Switched Digital Video: A movable feast? ■ PCS '97 technology roundup

America's Network

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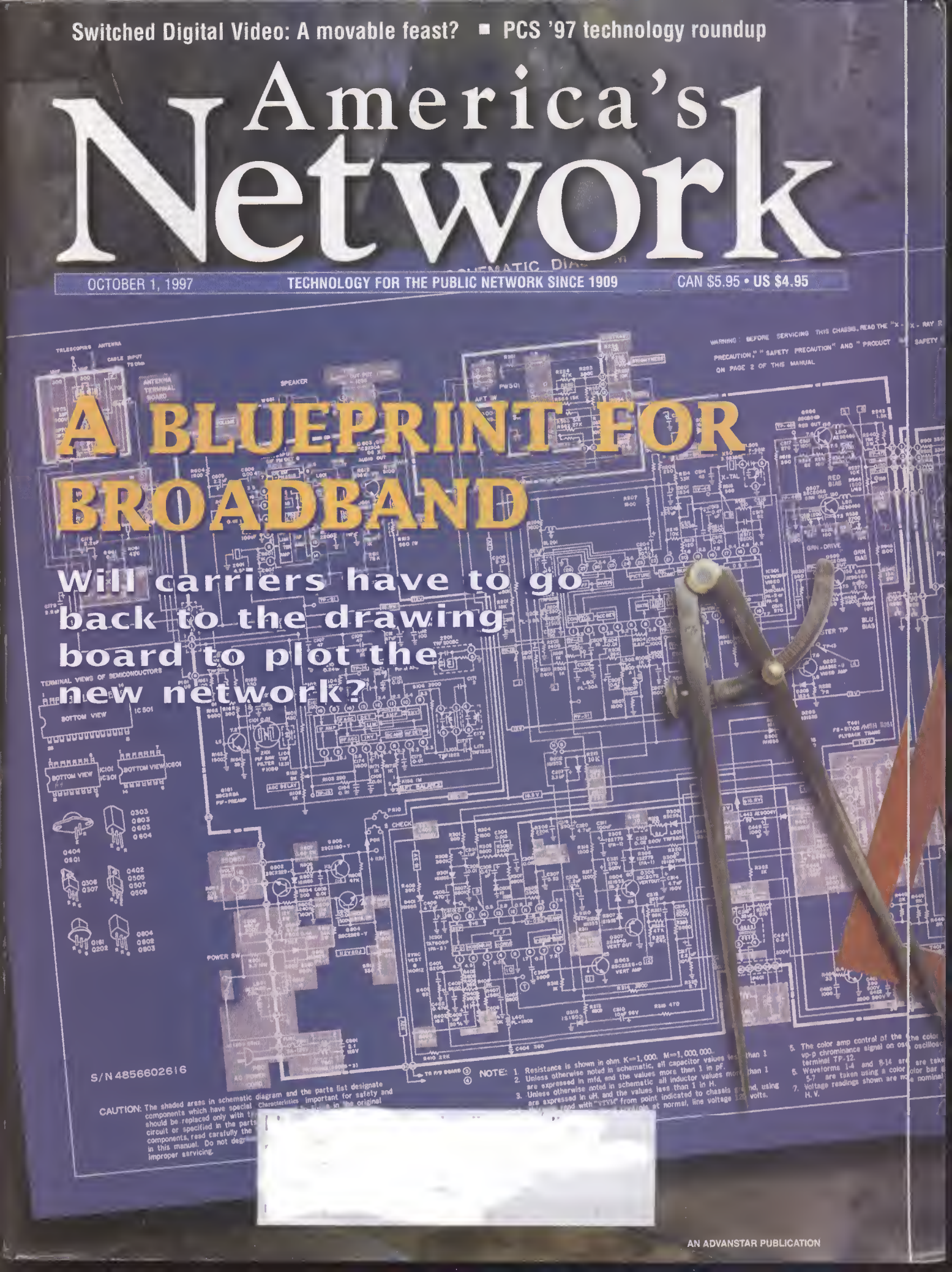

A BLUEPRINT FOR BROADBAND

Will carriers have to go back to the drawing board to plot the new network?

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Page 10: Contributing Editor Alan Stewart analyzes how carriers, vendors and other groups can properly baptize broadband in the public network. Photo montage by Jon Fraze

COLUMNS

BROADBAND

WIRELESS

DAVID KOPF

Networks won't cut it

Like it or not, the service you're providing isn't enough. Don't get me wrong, America's network service providers—from wireless carriers to telcos to cable operators—offer their customers some of the most robust, worthwhile communications services available in the world. From access technologies to backbone networks, you should be proud of the high-quality services you provide each and every day. It truly is a triumph of technological and business savvy.

Unfortunately, it is short-sighted in face of today's users' changing desires. Face it, the content that is traveling down your pipes costs your users money that will never contribute to your bottom line—that is, unless you do something about it.

Carriers can't be content with providing network services and network services only. That model has aged far past its relevance; the time has come for America's carriers to seriously look at the types of content they can provide over the next generation of networks slated for deployment.

For instance, why should a local exchange carrier stop at deploying asymmetrical digital subscriber line (ADSL) services? Sure, there are tried-and-true "sells" for ADSL, such as Internet access and telecommuting, but chances are that 'Net access will be provided by an Internet service provider at the other end of a virtual circuit (no content revenue there). Telecommuting goes right to a company's private network (nope, no content profit there, either).

So, why not create a whole new market? Devices such as set-top boxes and network computers may exhibit a great deal of profit potential as more users decide they want content services they've never considered having before. Case in point: recently, my 79-year-old father asked me when he will be able to buy a $500 computer that lets him read the online edition of *The Wall Street Journal* and do some word processing. It wasn't until two years ago that this man ever used a fax machine.

So, for example, why not offer my father, and the many computer-less users like him, a cheap network computer that incorporates an ADSL terminal unit? Then, don't stop at providing them 'Net access, but go a step further and rent them a server-based word processor based on a thin-client technology such as Java. Or, for a higher price, rent out a suite of business software. Why stop there—why not rent games to kids?

When the next generation of access technologies hit the service-rollout stage, will carriers be satisfied with being the middleman between content providers and users? Or, will carriers create compelling, profitable content for existing markets, as well as develop new markets through offering services that new users simply can't refuse to buy? It's your network, how do you want to profit from it?

David C. Kopf

America's Network

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America's Network evaluates emerging technologies, from a business-case perspective, for those who conceive, design and run America's public network. It is written for those responsible for design, deployment, operation and maintenance of public network elements. Readership includes local and long distance telephone companies, CATV companies, competitive access providers, wireless network operators, resellers, computer companies, and telecommunications industry suppliers and consultants.

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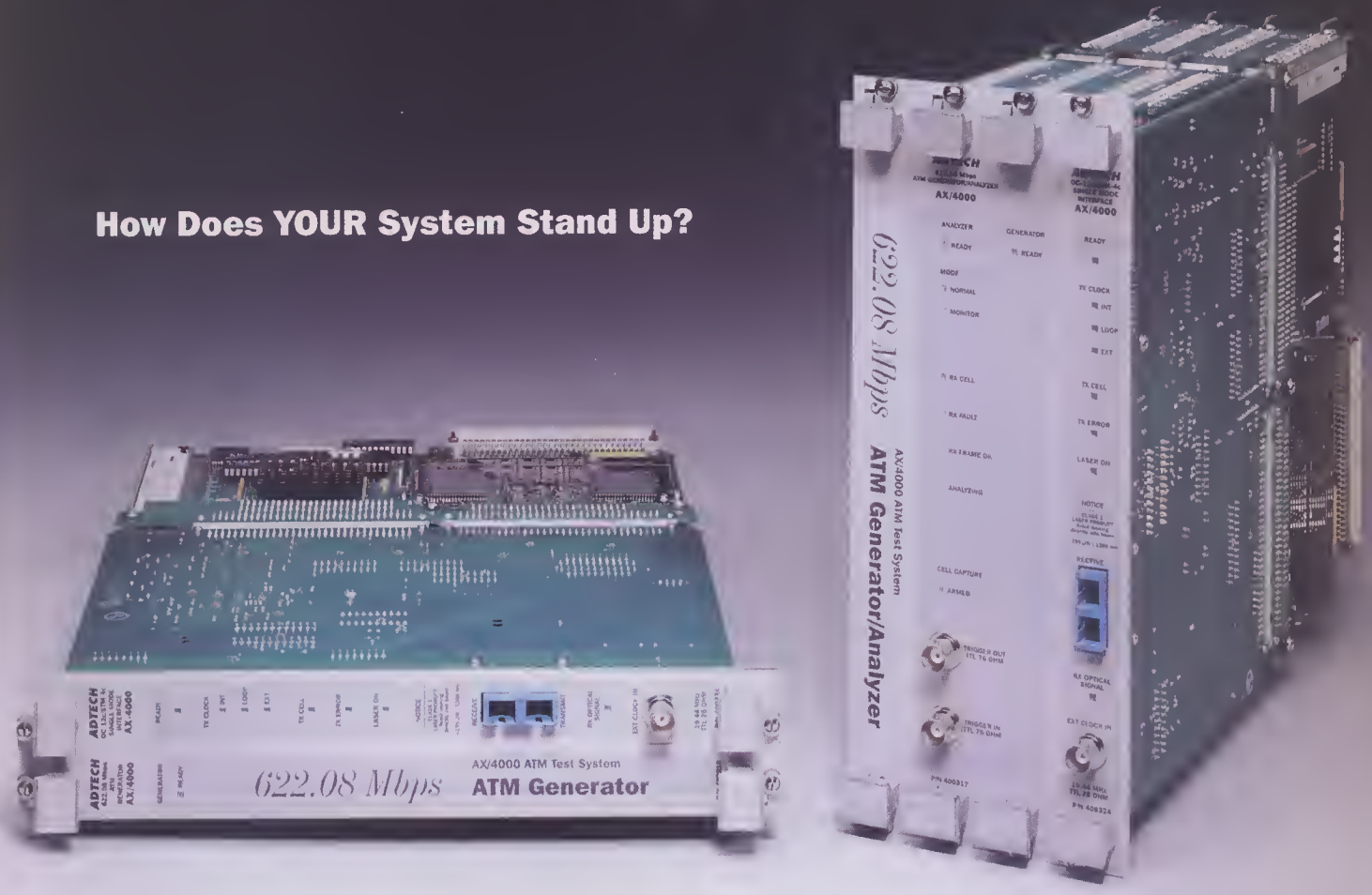

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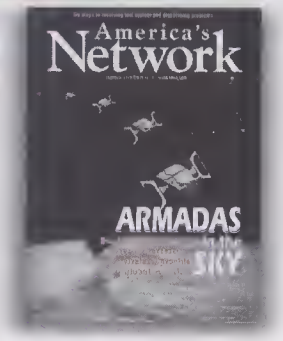

Local service vs. long distance service

I am almost in tears from laughing after reading Sprint chairman Bill Esrey's quote (Telecom Tantrums, *AN*, Aug. 15, 1997): "In this country, providing local service is distinctively different from providing long distance service—don't let anyone tell you differently. We know how to invoice and collect, how to deal with customers on a local level, how to market them, and how to become part of their community." Mr. Esrey has some nerve making this comment.

I have been in telecommunications sales in the greater Cincinnati area since 1983. Most of my business has been with Cincinnati Bell and, unfortunately of late, with Sprint/United Telephone of Ohio. Please read what it has been like dealing with Sprint/United Telephone of Ohio.

Case 1

We recently sold a Mitel PBX to a former Cincinnati Bell Telephone customer who moved to Mason, Ohio, which is served by Sprint/United Telephone of Ohio. The customer had a facility in Mason for a couple of years, and was moving the rest of the facility to a new building next door (approximately 100 yards away). The original facility in Mason had a signed contract with Sprint/United Telephone of Ohio for centrex equipment and service. Due to the high cost of centrex lines in the application, the customer either had to pay a $30,000 termination fee, or do a technological upgrade to ISDN for local service. Although T-1 service would have been adequate, it wasn't considered a technological upgrade. Therefore, we ordered two ISDN ORI spans for the new system to replace the centrex service. Upon requesting confirmation in writing, I was told that they do not provide written confirmations. Why?

For pricing and ordering, we were forced to deal with one person at Sprint/United Telephone of Ohio. This was the same person who originally sold the centrex service and was now quoting a new PBX, paging and cabling for that same new location. The existing centrex lines were terminated in the original building, and the PBX was to be installed in the new building. I sent a request to Sprint/United Telephone of Ohio approximately 30 days ahead of the cut. I was requesting the PRI circuits be moved to the new building, where the new system would be located. I also sent a copy of request to my customer. We also turned in an order to convert some existing centrex lines to DIDs. No problem said the rep (again, no written confirmation).

The day of the move, we found the PRI spans in the wrong building, (Surprise!) 300 feet away from the existing phone room (where the centrex lines had been terminated) into a patch panel, using standard unshielded cable. From there they went across the 100 yard underground conduit using standard Category 3 cable, and then into our new phone room.

Needless to say, the circuit didn't work. This was a Friday evening after hours, and we had four technicians onsite at time-and-a-half. The customer was moving in over the weekend, but the rep said he couldn't do anything until Monday.

Therefore, we had to run new cables and bill the customer for something that should have been done 30 days prior. Additionally, when we went to test the DIDs the centrex numbers which were to be converted weren't working (Surprise!). Luckily we were able to contact a Sprint/United Telephone technician who asked us what numbers were wanted. The Sprint/United Telephone of Ohio rep had been given a copy of the changes 30 days previous in writing, assuring me they would be converted (again, no confirmation in writing from Sprint/United Telephone of Ohio). The technician from Sprint/United Telephone of Ohio had no copy of the order (Surprise!) and gave us the numbers we requested. The customer also contracted Sprint/United Telephone of Ohio to run all new cabling (Cat 3 and Cat 5) in the new building, as well as install a new paging system for the new facility.

Although there were power poles and cubicles with wire mold, the jacks were left dangling off the cable in the middle of the cubes. To boot, the paging wasn't completed until after the customer had been in the new building for 30 days. We then discovered that Sprint/United Telephone of Ohio uses subcontractors for all cabling services. Although everything now is operational, Sprint/United Telephone of Ohio has made fools of themselves.

Case 2

A couple of weeks ago, I needed local T-1 pricing for another customer in the Sprint/United Telephone of Ohio area. It took four calls and five days to get a return call.

When I requested the cost, I had to give the company's name (remember: these are the same people against whom I compete), and it wasn't until two weeks later that I received something in writing.

Is this Sprint/United Telephone of Ohio's idea of how to deal on a local level? I challenge Mr. Esrey to call Sprint/United Telephone of Ohio and request a quote for ISDN and T-1 circuits. Then he should call Cincinnati Bell Telephone and see how it's really done.

Gary Holtmeir
VP sales, Wren Communications

Have something to **SAY?**

Send your comments to Editor, *America's Network*, 201 Sandpointe Ave., Suite 600, Santa Ana, CA 92707; fax 714/513-8634 or e-mail at editors@americasnetwork.com. Comments may be edited for clarity and length.

BILL ATKINSON

Beyond LAN's End

Telcos need to invest in customer-side strategies.

Carriers wishing to make successful forays into the LAN must anticipate needs for future services, especially Gigabit Ethernet.

Pervasive change in the Local Area Network (LAN) arena is creating enormous opportunity for telcos that understand what's happening on the customer side of the public network. Today's LAN decisions will have far-reaching impact beyond the local area tomorrow.

Carriers wishing to make successful forays into the LAN must know what is taking place within the customer premises so they can anticipate needs for future services. Telcos also should begin scouting for strategic partners to combat encroaching competition from traditional LAN vendors.

MARKET DYNAMICS

The Big Four internetworking companies—Cisco, Bay Networks, Cabletron and 3Com—have been executing strategies for invading the telco space. Others, like Ascend Communications, have already purchased the necessary technology and expertise to enhance carrier-class solutions from the edge of the network to the core.

Meanwhile, back at the LAN, network strategies are changing from the desktop to the backbone. Two years ago, industry pundits touted that Asynchronous Transfer Mode (ATM) would invade enterprises all the way to the desktop. Today, ATM has lost the desktop battle to Ethernet and the skirmish line has been pushed back to the LAN boundary. Ethernet's stronghold on the LAN was established by its age-old association with IP, and strengthened by Ethernet switching solutions, Fast Ethernet and Gigabit Ethernet (GbE).

According to a recent Forrester Research (Boston) report, *The Right LAN Backbone*, ATM will fade from corporate networks over the next few years and be limited to carrier networks. The report says that gigabit routing switches that support all flavors of Ethernet and provide IP routing will replace today's collapsed backbone routers.

The need for increased network capacity is driving the migration to this next-generation LAN technology. Growing numbers of network users, richer-content traffic, and the centralization of servers are all creating serious network bottlenecks. Rising backbone congestion is forcing LAN managers to adopt newer, faster technology sooner than anticipated.

EARLY ADOPTERS

A report by Sage Research says organizations with existing Fiber Distributed Data Interface (FDDI) networks will be among the first to migrate to next-generation backbone technologies such as GbE. This makes sense because these same people recognized previous bandwidth limitations and bought what were then leading-edge networks to increase capacity.

Sage says within three years, FDDI networks will be upgraded by 50% of those organizations using them today. With more than one million FDDI ports installed worldwide and equipment in place at more than 6,000 U.S. businesses, migration to GbE represents a significant market opportunity. San Jose-based research firm Dataquest estimates the GbE market at $2.9 billion per year by 2000. Analysts place the FDDI to GbE migration market at $1.9 billion over the next three years.

So how does a telco find out who is using FDDI? To start, FDDI has been the leading choice of organizations with more than 1,000 employees; many of them have adopted FDDI for its added fault tolerance and increased capacity. These companies will evaluate new technologies on the merits of bandwidth, reliability and redundancy. They will favor solutions that extend the life of existing equipment and cause the least disruption to operations during the migration process.

STRATEGIC ALLIANCES

A host of GbE start-ups have been fast to announce solutions such as Gigabit uplinks, buffered distributors and Layer 2 and Layer 3 switches. However, the Big Four have been slower to respond to GbE market momentum, but two have bought GbE start-ups in an attempt to deliver products sooner. But the Big Four will take longer to roll out GbE solutions than start-ups. They'll need to ensure compatibility with existing products and they'll need to prioritize GbE initiatives along with other corporate imperatives, such as infiltrating telco territory.

Telcos can take the battle into the customer premises by developing strategic partnerships. Alliances with providers of next-generation LAN backbone technologies will let carriers bring more customers into their camp while increasing bandwidth on both sides of the network. ■

About the author: Bill Atkinson is president and CEO of San Diego-based XLNT.

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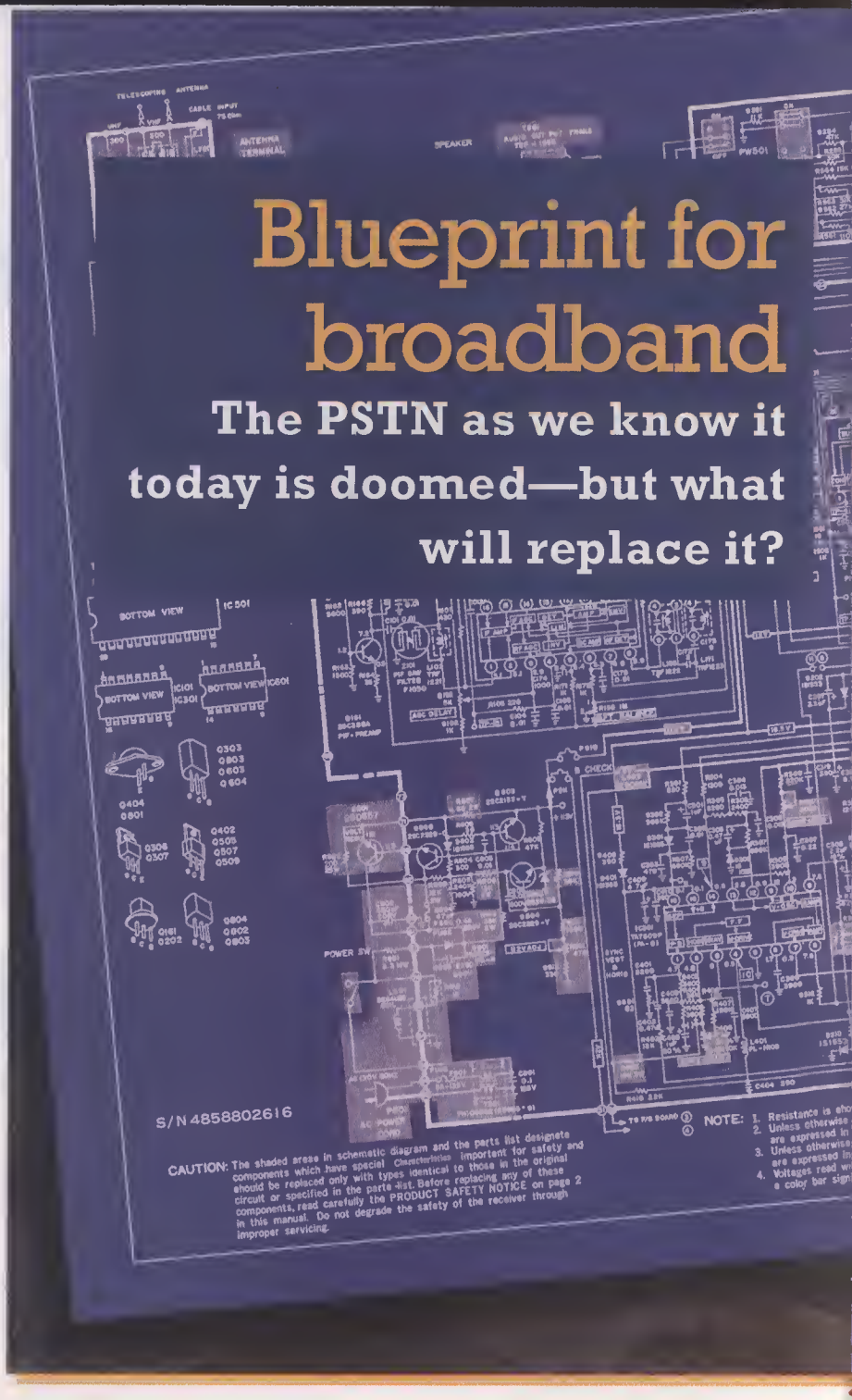
BROADBAND

Blueprint for broadband

The PSTN as we know it today is doomed—but what will replace it?



ESSAY BY ALAN STEWART

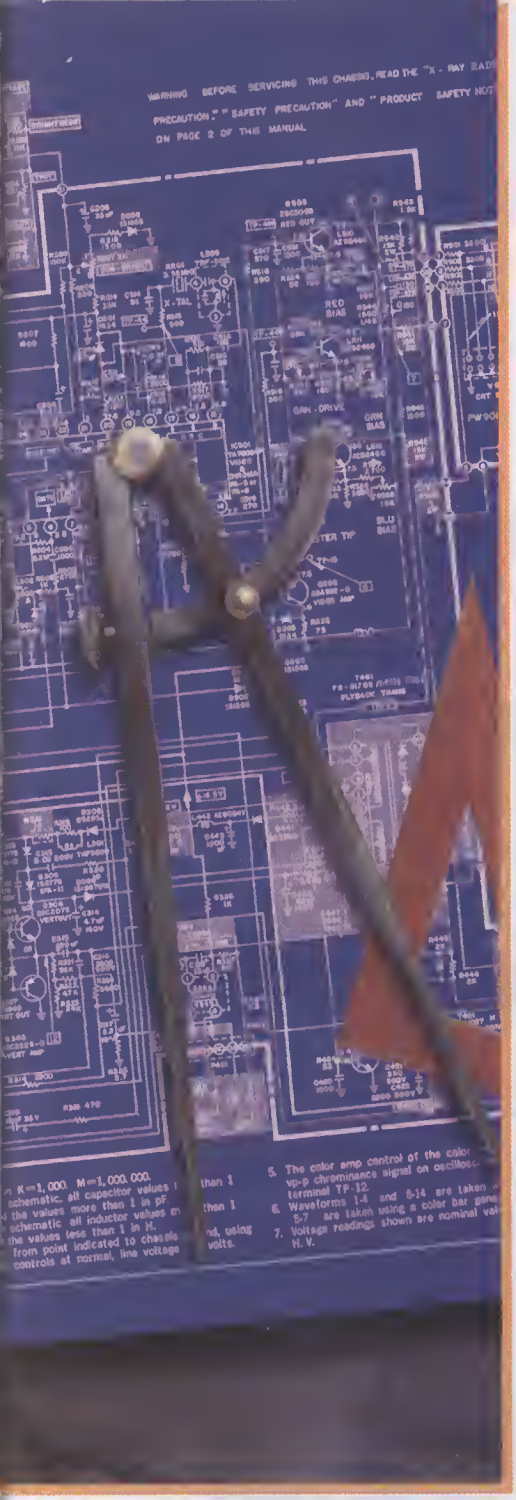
THERE IS NO SINGLE DIRECTION FOR OUR INDUSTRY—THERE ARE MANY. EIGHTEEN MONTHS AFTER THE FIRST MAJOR INDUSTRY LEGISLATION IN 60 YEARS, TELECOMMUNICATIONS TODAY OFTEN SEEMS LESS ABOUT SOCIETY'S NEEDS FOR INFORMATION THAN ABOUT THROWING NEW TECHNOLOGY AT THE NETWORK. A DECADE OF TURBULENCE HAS CAUSED THE INFLUENCE OF EQUIPMENT MANUFACTURERS TO SOAR AND THAT OF LOCAL EXCHANGE CARRIERS (LECS) TO PLUNGE. THIS CAN BE DAMAGING TO THE FABRIC OF OUR INDUSTRY.

It has become increasingly difficult to plot a logical path for the new broadband network, because we can no longer use the past as a guide. Although it seems certain that the public switched telephone network (PSTN) as we understand it is destined to die a slow and painful death, and no one knows what eventually will replace it. A growing demand for high-speed access has pushed the capability of the existing infrastructure to its limits. There are no easy solutions.

Why is this? Rapid changes in the way businesses and government communicate are one reason; the Internet is another. Private networks that evolved piecemeal over a 40-year span to connect teleprinters and mainframe computers are poised to encroach on areas that hitherto were considered part of the public infrastructure. What began as a strategy to accommodate the needs of corporate communicators is now touted as the final solution for all subscribers.

Modern private networks differ from public ones, mainly because public solutions were applied piecemeal. This led to major divergences in geographical coverage, access and the nature of end-user information. Today's philosophy seems to be that, because modern microprocessors make it possible to solve any information problem—given enough millions of instructions per second (MIPS)—we should use them everywhere. Unfortunately this approach does not always work well in 50-year-old legacy networks.

Broadband in any form, anywhere is the watchword of contemporary telecommunications. Some vendor strate-



gies appear to be driven less by the real needs of the carriers than by an effort to sell new products. Intense promotion of these products can confuse carriers as they struggle to make the transition from narrowband, circuit-switched services to broadband, packet-switched services. A byproduct of the industry's drive for speed, more speed and even greater speed is a reduced understanding of the orderly processes of information transfer.

The post-divestiture public network is dichotomous. The backbone is broadband and flexible, and can manage a high volume of voice and data traffic in digital form. The access network is narrow and inflexible, and transports mainly analog voice and voice-band data using a variety of legacy techniques. Little progress can be made until the latter is digitized.

Innovation alone cannot resolve the problem. As Nicholas Negroponte of the Massachusetts Institute of Technology (MIT) points out, massive deployment of fiber in the access network is required. The long-term solution consists of strategically placed multisubscriber distribution terminals connected to the end user by copper wire or wireless means. To pay for this infrastructure, network providers must offer profitable services in an environment that is free from unnecessary regulation. Synchronous optical network (Sonet) transport, high-speed cell switching and computerized signaling can realize their full potential only in such an environment. In other words, they must be brought to the subscriber's doorstep. This means connecting access nodes together with self-healing rings, providing asynchronous transfer mode (ATM) switching at the edges of the network, and designing customer terminal equipment to open-systems standards. This is an expensive proposition.

Private networks cannot continue to provide improved connectivity with proprietary devices.

BUSINESS NETWORKS

Businesses are driven by a need to add new services constantly. In the past, this caused them to adopt technologies that often were immature. Rapid migration took place from X.25 to frame relay to ATM. Running these over the legacy backbone required a multitude of routers, bridges, gateways, multiplexers and digital cross-connect systems (DCSs). The vendors meeting these needs specialized in short-term solutions. The result was a mish-mash of dissimilar systems that needed constant updating or replacement.

Applications that require high-speed transport—such as video conferencing, telemedicine, distance learning and multimedia—require a unified approach, such as a broadband integrated services digital network (B-ISDN). The standards to implement this reside mainly in the public arena. A massive transfer of technology is needed; most small- and medium-sized businesses are fed up with the long, drawn-out process.

Private networks cannot continue to provide improved connectivity with proprietary devices. Cisco Systems, Hewlett-Packard, Sun Microsystems, Newbridge Networks and other vendors recognize that uniform standards are needed to handle a client-server network environment. Backbone ATM switch manufacturers have made major product upgrades to achieve compatibility with different devices and continuous bit-rate information content; however, there still is a long way to go.

The convergence of telephone and computer products has demonstrated this effort, and is best undertaken in the public and private network arenas simultaneously. There is a need to replace the legacy network with an entirely new infrastructure. This involves integrating public and private networks, which evolved differently but which now must carry similar services.

THE ACCESS CONUNDRUM

Traditionally, technology has been used to improve network operations and effectiveness. For half a century, the benefits to providers and subscribers were obvious. The overriding priority was to maintain and gradually improve a public network which could support high standards of basic service. This was an extremely slow process and led to a massive installed base of narrowband switches and transmission systems.

A decade ago, the advent of powerful microprocessors turned things around. The impact on public and private net-

works was substantial and far-reaching. Long distance providers specified and deployed a high-speed digital backbone using the traditonal Bell System approach. Private network vendors supplied private networks with specialized routers, bridges and multiplexers to connect computers to each other and to wider area networks.

This led to the situation we have today. In the public network, data users are cut off from a broadband backbone by fairly low-speed, inflexible access circuits. In the private arena, larger end-users enjoy fairly fast connectivity but tend to be confined within a complex environment created by a multiplicity of proprietary devices.

Traditional carriers are exploring ways of providing subscribers with broadband interactive multimedia services through the use of asymmetrical digital subscriber line (ADSL). Bit rates of 6 Mbps and greater can be transmitted over ordinary copper cable to the home or office. The !nterprise service recently announced by U S West takes this approach (Figure 1).

It is unlikely that such a solution will be widely deployed. There are major problems with transporting high-bit

Asked which technology has had the most impact on the industry since 1990 most people would probably say "wireless."

data streams over conventional outside plant, not the least of which is the problem of interference. A more likely scenario is to deploy fiber to intermediate locations and use a variety of physical media or wireless technologies to connect the final mile (Figure 2).

AMPLE SPECTRUM

Asked which technology has had the most impact on the industry since 1990, most people would probably say, "wireless." For the first time in history, there is ample spectrum for all kinds of communications. A few years ago, the Federal Communications Commission (FCC) gave away 100-megahertz chunks of spectrum at 38 GHz to WinStar and other companies because these chunks were considered of no practical value. Now they are marketed as "wireless fiber" and are potentially worth billions of dollars.

Figure 1: xDSL components

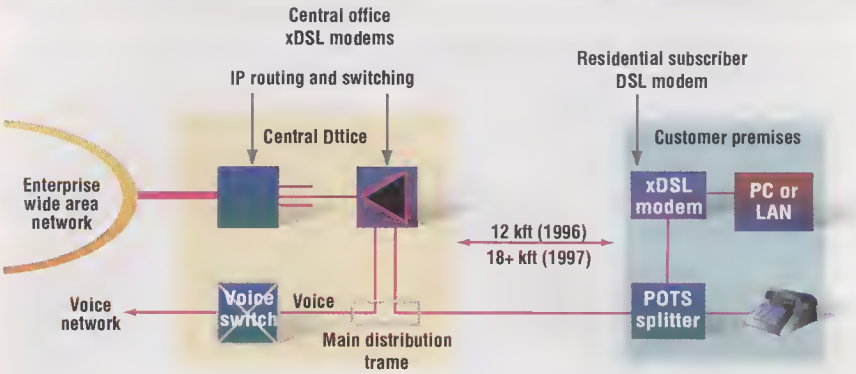
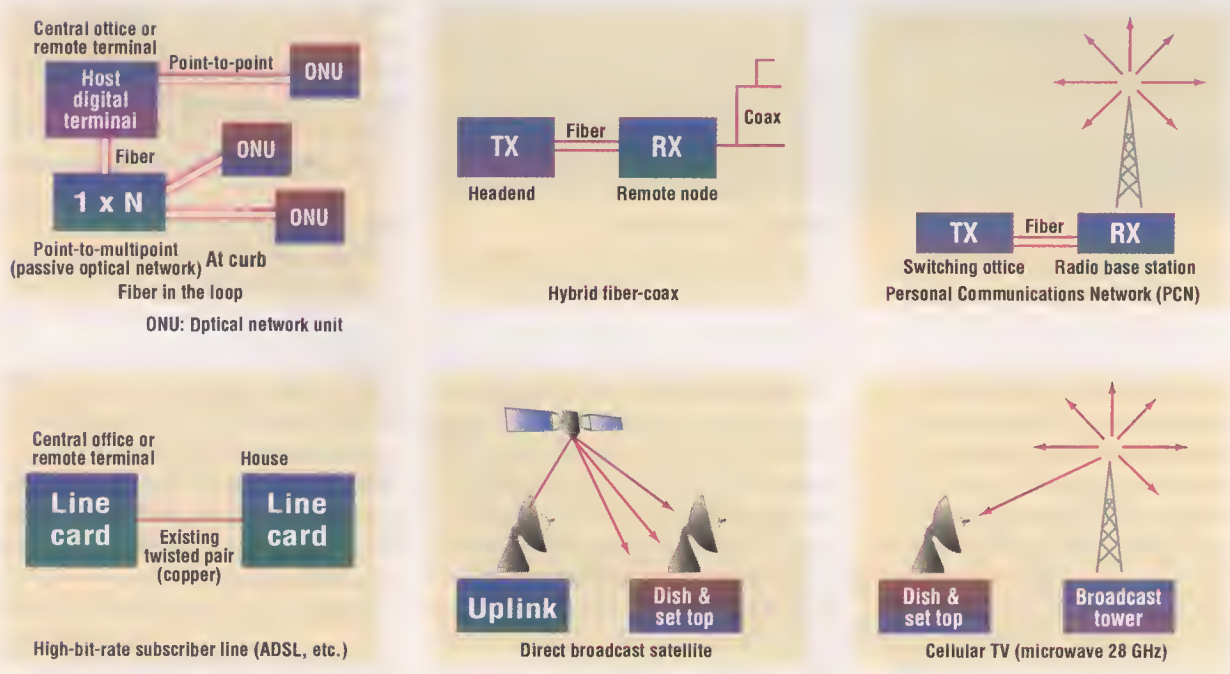


Figure 2: Technology options for the loop network



What I

WANT...

Wireless is not a single entity. It is family of technologies and a family of services all rolled into one. For example, advanced mobile phone service (AMPS) and direct broadcast satellite (DBS) have little in common; yet both are used by millions of subscribers. What makes them successful is that they provide end users with something they want and are prepared to pay for.

Just like any other solution, broadband wireless has to be carefully administered and marketed if it's to become an integral part of the infrastructure. Eventually, it will replace wireline for many access applications; however, a number of questions remain:

- How do narrowband and broadband wireless relate?
- Where is cellular phone headed?
- When will digital radio supplant analog?
- What are personal communications services (PCS) and can PCS be integrated into wireline?
- Can broadband wireless carry interactive services?
- Can the Iridium and Teledesic satellite systems replace terrestrial networks?

REGULATORS ARE PREOCCUPIED

For many years, the emergence of broadband was controlled by politics and regulation. New technologies were applied in a circumspect way so they wouldn't disturb the smooth evolution of public telecommunications.

The sudden popularity of the Internet has thrown a wrench in the works. Today, information providers, manufacturers and business users are struggling with its implications. This leaves regulators preoccupied with the dangers of the Internet rather than its opportunities.

Wireless and communication satellites will play a massive role in information access over the next five years. In January, AT&T chairman Robert Allen told the National Press Club address as much. He noted that the availability of spectrum for these access technologies is key to opening up Judge Harold Greene's infamous "bottleneck." The

For many years the emergence of broadband was controlled by politics and regulation.

role of the FCC in allocating frequencies is crucial to this process.

What happens to all the new technologies that enter the market each year? Don't we have Sonet, ATM, ADSL, code division multiple access (CDMA), broadband wireless and a host of other solutions that could provide fast Internet access? The short answer is yes, but local telephone subscribers seem unable to benefit. The baby Bells are slow to respond, because they are preoccupied with losing control over local service ("Silence of the Bells," *AN*, Jan. 15). Under the terms of the 1996 Telecommunications Act, the regional Bell operating companies (RBOCs) were supposed to open the local loop to competition. The FCC was charged by Congress with administering this process through its unbundling regulations. Subsequent litigation caused the RBOCs to cut back on their plans for faster access networks.

IS NII POSSIBLE?

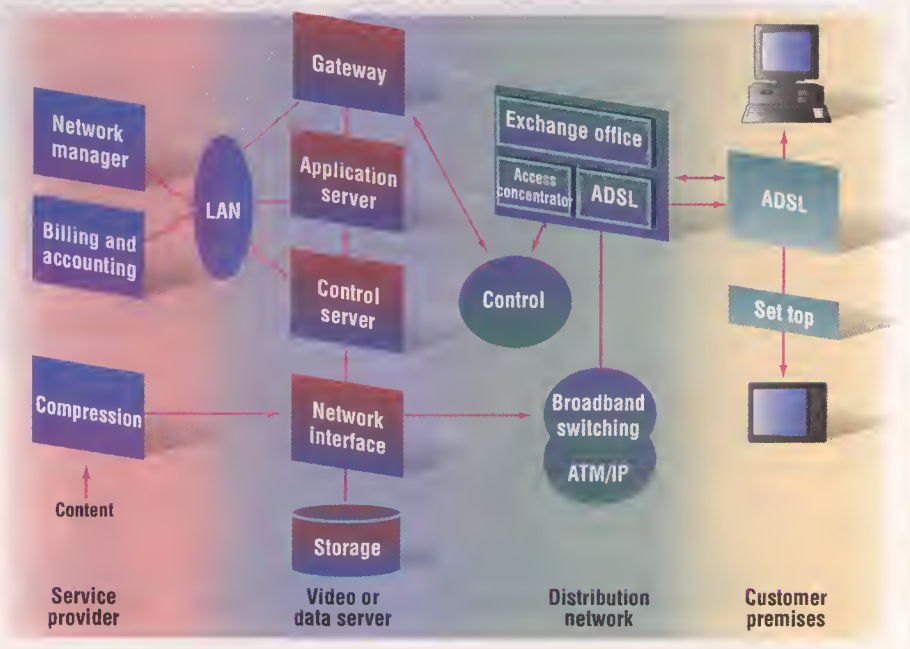
The deployment of the National Information Infrastructure (NII) has a long way to go. Touted as the key to the future by politicians, it is, in reality, a vast and ill-defined cloud of switches, wires, wireless and signaling systems that embraces telephony, computing, video and broadcasting.

A major hurdle is the need to define the purpose of this monstrosity. Although Vice President Al Gore's vision is to connect all citizens to a broadband highway, the questions that must be answered first are among the most difficult our industry has faced:

- Which portions of the public network should continue to be regulated and why?
- Will public and private networks become one and the same?
- What are the common applications by users of both networks that justify this convergence?
- Can current legacy networks be adapted to handle today's telecommunications needs?
- How can regulators best facilitate the emergence of new products and services to benefit end users?

continued on page **18**

Figure 3: Broadband interactive multimedia architecture



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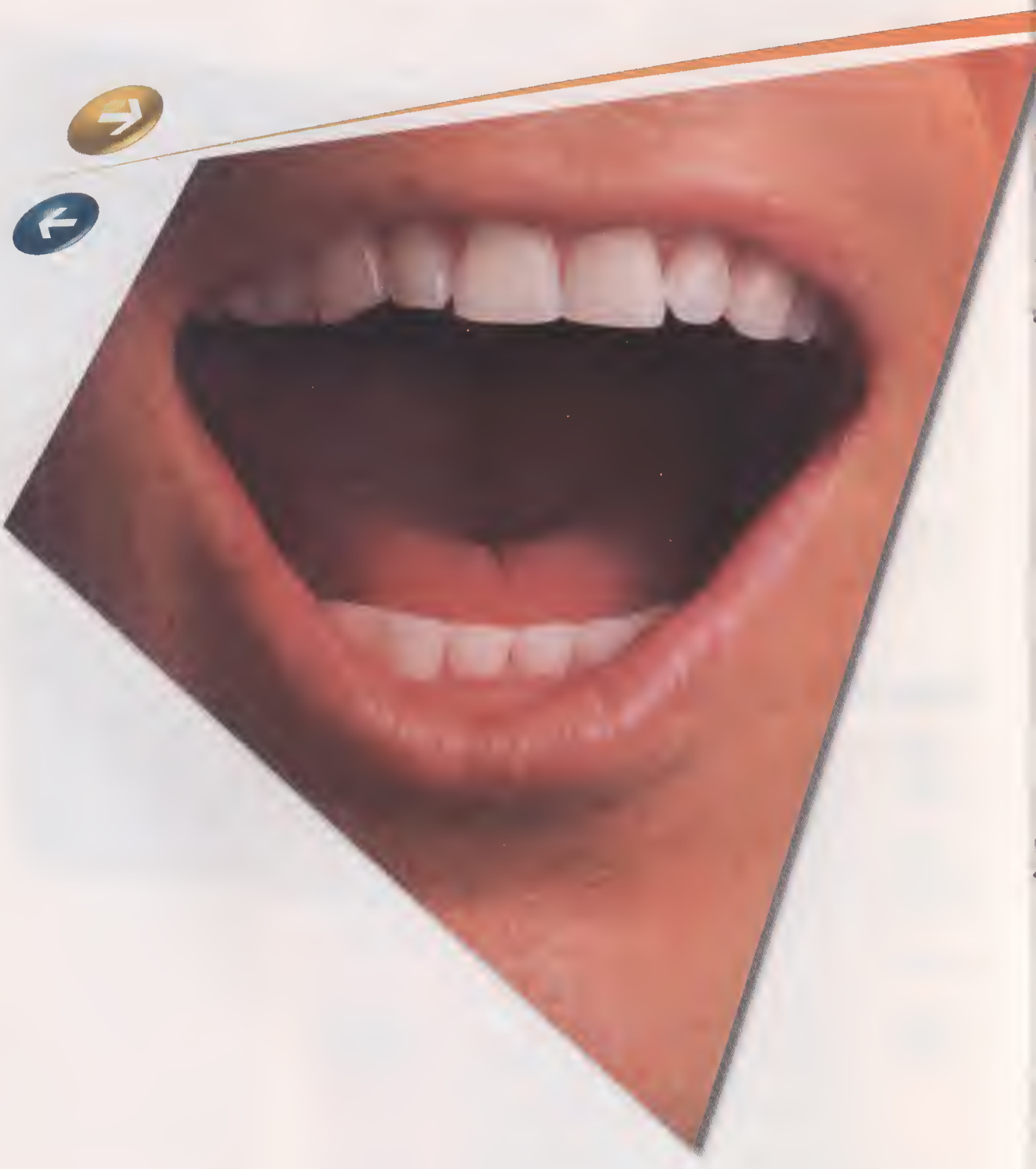

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continued from page 14

- What are the most effective roles of providers, vendors and users of the network in carrying out the process?
- How best can we use the lessons of ISDN to achieve universal access quickly and efficiently?
- What is the purpose of the NII?

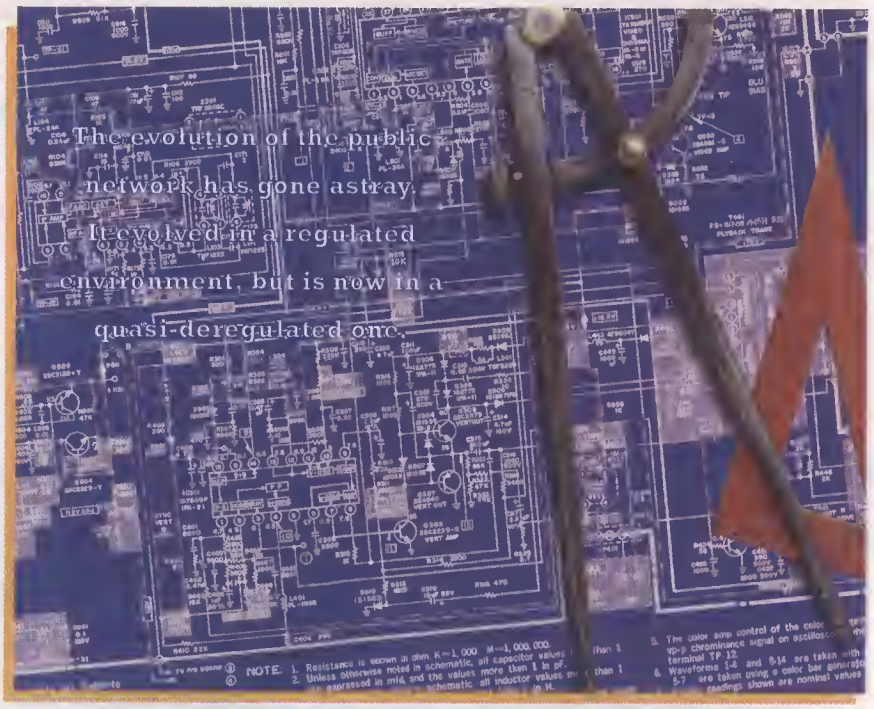
Until recently, the major players have failed to answer most of these questions. Although they hold responsibility for creating a more accommodating network for end users, their track record has not been good—and neither has the government's. During the early years of the North American ISDN Users' Forum (NIU-F), the National Institute of Standards tried (and failed) to provide leadership to the industry in creating an end-to-end digital network.

Coordinating the introduction of new technologies is not easy. As the various participants go through the long, drawn-out process of system design, product development, standardization, deployment, interoperability and quality control, they often lose sight of their primary objective, which is to make life easier for subscribers.

Participation in broadband is significantly retarded by this fact. Public telephone subscribers have little voice in the evolution of the network. Private users often are too involved in keeping their networks running smoothly and dealing with vendors to worry about the big issues. Telecommunications and MIS departments do not use the same infrastructure, share the same priorities or even speak the same language.

We should recognize that the historical structure of telecommunications made this situation inevitable. A decade of post-Bell System maneuvering and judicial activism plus several years of industry debate leading to the 1996 Act changed the rules, but the old ways of doing things persisted.

Today, vendors like Tellabs, Telco Systems, DSC Communications, Broadband Technologies, Oracle, Cisco Systems and a host of others have the expertise to do the broadband job. Carriers such as AT&T, the RBOCs, GTE, Worldcom and Time Warner have the networks to deploy new services. End users like Boeing, Kodak and General Motors can run new applications. Industry-wide groups such as the ATM Forum, standards bodies like the American National Standards Institute (ANSI) T1 organization, and users' groups such as NIU can foster faster interconnectivity.



THE BLUEPRINT

The evolution of the public network has gone astray. It evolved in a regulated environment, but exists now in a quasi-deregulated one. Although we should allow scientists and engineers free reign to develop new solutions, we must, at the same time, meet the needs of network users. In other words, we must create products of long-term use. No barriers should be laid in the end-users' paths. The modern broadband access network must accommodate all who can benefit.

Understanding network evolution is the first priority. The knowledge to do this resided originally in well-established organizations such as Bell Laboratories, Bellcore and Bell-Northern Research (BNR), whose primary function was to integrate the components that make public networking ubiquitous. Because of their experience, these entities played an essential role in ensuring network evolution took place in an orderly manner. The expertise of these organizations must now spread throughout the industry.

The government has neither the time nor the inclination to plan information networks on a national or global scale. The most it can do is to abolish regulations that retard logical evolution. The government is at its most effective when it fosters an environment that makes optimum use of technologies such as Sonet, ATM, advanced intelligent network (AIN) and computer-telephony integration (CTI), and the products and services that result.

We must leave it to the private sector to clarify the strategies needed to optimally use new technology. These strategies must lead to uniform delivery of broadband information required to network knowledge to the public. Anything that disturbs this process is undesirable and makes designing a blueprint for broadband more difficult. ■

Contributing editor Alan Stewart is a freelance writer, lecturer and telecommunications consultant based in Crystal Lake, Ill. He represented Eastman Kodak on the North American ISDN Users' Forum and is a founding member of the ADSL Forum.

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BROADBAND

FRANK BERNHARD

Framing the public network backbone:

A close look inside the ATM revolution

Not long ago, developers conceived a network switching technology that could meet user demands for integrated voice, data and video throughout the enterprise and harness the power of the Internet. Welcome to the invasion of Asynchronous Transfer Mode (ATM). Throughout today's public network, ATM devices continue to populate carrier switches—yet many operators use the backbone for X.25 or frame relay communication in a strict data environment—leaving multilevel services and voice transmission on the sidelines.Traditional broadband technologies abandon the critical element of service elasticity—the ability to furnish bandwidth on demand and further distribute idled capacity throughout the network. The singular feature of flexible service provision is an insightful market opportunity that clearly segments the customer population—not only to target audiences, but also to construct price discrimination tools carefully.

Yet, customer segmentation via price and service levels does not act independently to the inertia of economic benefits realized by ATM implementation. Contemplate the reward of increased bandwidth as a pure commodity. Technology must step forward with the market conditions that compliment user demand.

Market Engineering

TECHNOLOGY KEEPS PACE ALONGSIDE BANDWIDTH DEMAND

As the desktop environment fuels the integration of multimedia capabilities, market research indicates a growing trend toward increased propensity of remote communication services and relevant initiatives to add PC-based telephony features. In fact, recent advancements in thin-client computing have forced the issues of network capacity and performance to the spotlight. More than ever, technologists realize the centric nature of the network and the role of bandwidth demand when considering expansion projects.

ATM prevails strongest in transport speed (9.5 Gbps, theoretically) and scalability to the desktop environment. When compared to fiber distributed data interface (FDDI) at 4,500-byte frames or Ethernet at 1,500-byte frames, ATM demonstrates smooth voice and video characteristics due to its relativity short cell length of 53 bytes. Inherently low transmission delays guarantee real-time delivery of collaborated image and voice data for dynamic resolution and sound quality.

With this marked achievement in bandwidth, the dominant factor for ATM's acceptance will be derived from the application development community and the embrace of standards to ensure cooperation.

A NEW DERIVATIVE FOR USER BENEFITS

Taking an introspective look at the network services market, one must realize that the customer base no longer is a single, mass population, but a schematic of varying business requirements and demands for tailored service level agreements (SLAs). The very essence of changing bandwidth demands and

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Technology acceptance will be derived from the application development community and the embrace of standards to ensure cooperation.

the application perspective will carve out niche segments to yield a suite of tiered service structures.

Today's ATM technology gives the customer a new set of preferences, maximizes the network's potential as a transport mechanism, and allows improved operational efficiency as a bonus. Increasingly robust data integrity and improved reliability are just two of the beneficial factors impacting a customer's financial valuation of ATM networks. Beleaguering costs of network downtime account for nearly $1 billion annually in lost revenues to network-critical firms which depend on connectivity for business operations, according to analysts.

Yet, the emergence of ATM doesn't promise to solve network failures or contain leakage from customer data streams. The technology simplifies an architecture that enables enhanced network visibility (firmware and software), direct end-to-end connections for security and refined use of network resources for efficiency gains. Of course, the financial rewards (cost savings vs. marginal revenue) may be tabulated by assessing baseline business activity. Some firms boast operational gains soaring to 35% when contrasted to pre-ATM network implementation.

THE INTRIGUE OF COMPETITIVE ADVANTAGE

In a sea of network service operators, the heart of positioning ATM technology resides in the carrier's distinct ability to offer multiple categories of service in determination of the subscriber's data environment. Through the use of service blocks and ATM virtual path connections (VPCs), providers may prescribe a category based on selection of an appropriate ATM adaptation layer (AAL) to fit the customer's application suite.

The ability to segment the service offering provides several intrinsic benefits to carriers:

- The inherent function to control and define network procedures and parameters will minimize traffic congestion and improve throughput. Reduced network complexity enables intelligent resource loading and maintenance.
- Varied service categories permit efficient distribution of traffic and thus optimize available network devices for handling proficiency. Fewer firmware devices drive down the cost of network ownership and invariably provide sustained opportunities for greater traffic capacity. Enlarged capacity translates to significant revenue gains.

In light of other broadband technologies, ATM is well-suited to cater to the needs of subscribers who share inconsistent bandwidth specifications. The real value is found in the payment for strictly the service used.

ATM PRICE STRATEGY: THE OPEN BALANCE SHEET

A majority of IS managers agree: The market compass points toward the desktop. Network technology decisions begin with a careful total cost-of-ownership examination at the desktop level. Depending on the application, selection criteria focus on the impending bandwidth crisis.

The paramount issue among service providers is the ability to set price tariffs

Table 1: Glossary of ATM terms

AAL	ATM adaptation layer
ABR	available bit rate
ANSI	American National Standards Institute
API	application programming interface
ATM	asynchronous transfer mode
B-ISDN	Broadband ISDN
CBR	constant bit rate
Cell	a unit of transmission in ATM
FDDI	fiber distributed data interface
nrt-VBR	non-real-time variable bit rate
QoS	Quality of Service
rt-VBR	real-time variable bit rate
SNA	simple network architecture
UBR	unspecified bit rate
VCC	virtual channel connection
VLAN	virtual local area network
VPC	virtual path connection

Table 2: Economic and technology benefits of ATM deployment

Network Service Provider	Customer
Network visibility	Data integrity and network security
Management simplicity	Increased bandwidth for new applications
Scalable service demands	Varied service level agreements
Multiservice capacity	Improved network reliability
Maximized resource utilization	Minimized fee schedules
Tariff price strategy	Efficient bandwidth consumption

Table 3: ATM service category applications

Category	User application
Constant Bit Rate (CBR)	Videoconferencing
	Telephony
	Audio/video retrieval
	Audio/video distribution
Variable Bit Rate (VBR)	Data transfer
	Time-critical transaction applications
	Process monitoring
Available Bit Rate (ABR)	LAN internetworking services
	Lan emulation
	Data communications
Unspecified Bit Rate (UBR)	Telecommuting (remote terminal)
	Text/data/image transfer and messaging

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in accordance with service provisions. Historic price strategies were benchmarked by fixed port volumes, regardless of metered use. With the advent of ATM's categorical service separation capability, carriers now find themselves in a lucrative position to attract a wide range of customer groups—and further discriminate by the application environment (Table 3).

For example, customers using ATM switching for time-crucial transaction processing may consider a variable bit rate (VBR) service category, because sustained throughput is not an issue of transmission quality. However, providing video conferencing capabilities would be enabled through a constant bit rate (CBR) agreement. Here lies the novel approach to purchase a distinct level of service matching the use of the application. Service operators need to allocate resources effectively to those customers requiring an appropriate bit rate level.

Quite interestingly, optimal efficiency of capital and resources will reach a point of equilibrium and economic benefits will be realized for both the consumer and the supplier.

IMPLICATIONS OF TOMORROW'S NETWORK

To accelerate an adoption curve comparable to that of the Ethernet during the 1980s, ATM will require the continued maturity of the application environment—especially in the area of application programming interfaces (APIs) to address awareness for bandwidth planning and flexible transmission factors. For the network engineer, the challenge will be to evolve a simple architecture to satisfy current user connectivity, and to predict future growth relative to the organization's rate of technology integration.

With time at the doorstep, ATM's current state of maturity beckons a serious inquiry to service providers and customers alike: They must examine the network fabric and implement new technologies according to the change of business process. Tomorrow's applications will deliver new dimensions of user interface and equal burdens for paralleled network performance. Consider the contemporary architecture of ATM. A revolution is underway. ■

Frank Bernhard is a principal economist and market consultant in Northern California. He can be reached at fbernhard@advanstar.com

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Switched Digital Video: A movable feast?

SDV finds a robust market despite an Internet rush toward packetized video.

SWITCHED DIGITAL VIDEO (SDV) IS POPPING UP JUST ABOUT EVERYWHERE THESE DAYS—FROM "VIRTUAL MEETINGS" IN CORPORATE CONFERENCE ROOMS TO BANKING KIOSKS AND REMOTE SHOPPING NETWORKS TO COLLEGE CAMPUSES AND SURGICAL THEATRES. SOMETIMES CALLED "SDS" (SWITCHED DIGITAL SERVICES) VIDEO AND MORE COMMONLY SWITCHED 56, SWITCHED 64, INTEGRATED SERVICES DIGITAL NETWORK (ISDN) VIDEO AND, MORE RECENTLY, FIBER TO THE CURB (FTTC): ALL THESE BUZZWORDS REFER TO ANY NUMBER OF DIGITAL TRANSPORT TYPES THAT CARRY CIRCUIT-SWITCHED VIDEO (NOT PACKET VIDEO) OVER CLEAR CHANNELS WITH QUALITY OF SERVICE (QOS) GUARANTEES.

SDV was once considered a stepchild of another stepchild—ISDN—and its world of selective, but not very popular corporate digital data services. Today, switched video is enjoying a great leap forward. "It's become a profound business as ISDN becomes a more vital business," claims Dick Slezak, managing director of AT&T Global ISDN.

"ISDN is growing at a rate of 90% to 100% per year, and this year we expect to carry just under 1 billion minutes of traffic," Slezak says. "The drivers behind ISDN are twofold: about 60% of that traffic is video conferencing, and the other half is electronic courier services, which means the distribution of large files (including video clips and frames) according to particular kinds of timers [timing constraints]." In short, the "video courier" business is hot, Slezak concludes. "SDV is used constantly in the pre-press, advertising agencies and other creative houses," he says. "For the distribution of video clips, and also in the case of audio and radio advertisements distributed with time urgency, electronic courier services are using circuit-switched video where the Internet [and packet video] wouldn't be appropriate."

BEYOND GLOATING

AT&T is not the only carrier experiencing solid SDV growth. Sprint is one of the hottest switched digital carriers in the country, offering a hybrid Transmission Control Protocol/Internet Protocol (TCP/IP) network product—actually a form of switched digital Intranet known as "Drums." Billed as a Sprint exclusive, a "multimedia collaboration service" geared mostly for the post-production, advertising and entertainment industries, Drums allows TCP/IP "bonding" of Internet bandwidth into 1.5 Mbps streams—then conversion onto Sprint's QoS-guaranteed switched digital video network via a gateway device.

"Essentially we put up end points at the customer premises that take the TCP/IP bandwidth and convert to switched digital service using multilink point-to-point protocol (MLPPP)," says Scott Crowder, director of advanced product support at Sprint. "At the [customer] end points, we're doing TCP/IP packet switch conversion using Ascend technology," he explains, "and we have POPS around the country aggregating the bandwidth into 1.5 megs. This means that when you're on Drums, we control the gateway, the firewalls and

Principally an Internet application, in which video is encapsulated in the TCP/IP transport stream, the H.323 packet standard has no QoS guarantees, but offers two advantages: low entry-point pricing and eventual ubiquity.

the authentication. [In effect], you're on a switched digital Intranet with guaranteed QoS and a gateway to the Internet. By bonding that bandwidth together onto SDV, we allow TCP/IP to flow without latency or QoS issues. This is the closest thing in the industry to a QoS guarantee for those who have an Internet (or packet video) connection."

Sprint claims the total global market for SDV today is close to $500 million. "But the exact transport piece is unknown," says Amy Holmes, group manager for Sprint's Enterprise Service. "Ninety to 95% of the market for video today is still switched digital," she says. Indeed, SDV is comprised of many transport families—including ISDN basic rate interface (BRI) and Primary Rate Interface (PRI), Switched 56 services, Switched 64—which includes aggregations of 56 kbps or 64 kbps transport streams (generically, known as "fractional T1" on up to 384 Kbps.) In addition, fiber to the curb (FTTC) can carry 56 Mbps for video, data or voice; regional Bell operating companies (RBOCs) such as Bell Atlantic are demonstrating FTTC's use in selected residential locations.

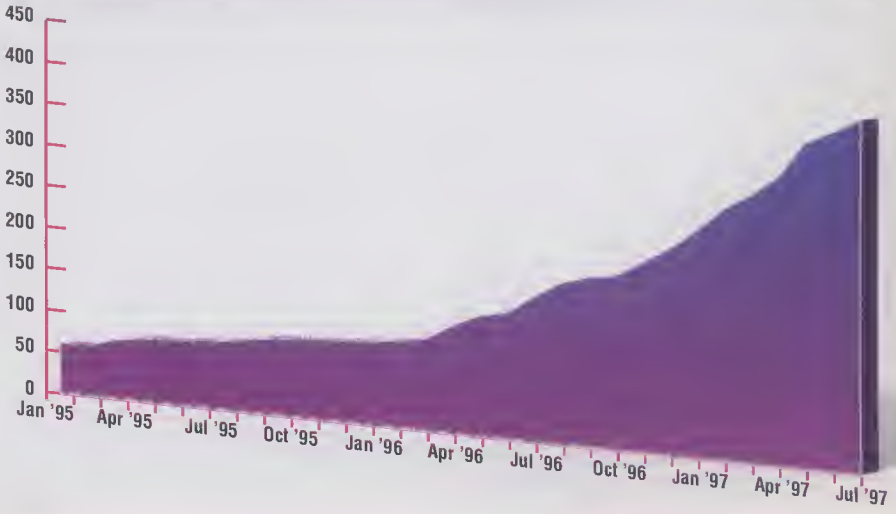
The standardized SDV format, however, is known as H.320, actually a 384 kbps standard promulgated in 1992 by the International Telecommunication Union (ITU). H.320 delivers near-TV quality video (approximately 30 frames per second) over digital pipes (generally ISDN BRI or PRI) with a guaranteed clear channel. By contrast, "packet video, standardized by the ITU as H.323, is still in its infancy," Holmes claims. Principally an Internet application in which video is transported in encapsulated format within the TCP/IP transport stream, the H.323 packet standard has no QoS guarantees, but offers two possible advantages: low entry-point pricing and eventual ubiquity. Microsoft claims it will be distributing up to 50 million copies of its Internet-based H.323 video conferencing product, NetMeeting, by the end of 1998; numbers like these easily could skew the market toward packet, although Sprint believes a hybridized network linking the best of switched video with packetized/TCP/IP elements (along the "Drums" model) is most likely.

"The advantages right now with SDV are that you have a switched 56 or 64 guaranteed channel, and no packets or intelligent transmissions [are part of that], such as TCP/IP overhead," Holmes says. "Because H.323 is encapsulated within the TCP/IP video stream, it takes away from video quality. To get close to acceptable video [with packets], you'd need close to double the [384 kbps] bandwidth."

Holmes says that ISDN and associated SDV technology "will continue to dominate" this year and into the latter part of next year. "That's before ATM and IP and POTS start to do anything [in broadband] in terms of the total market," she says.

After that, IP-based packetized video will begin to grow, as will ATM and other technologies that could transport video traffic, such as xDSL. By 1998, at least 85% of the video market still will be in switched digital services, according to Sprint. But by 2000, SDV could comprise as low as 50% to 55% of the total market, with packetized video, including the IP-based H.323; its analog video "sister" standard, H.324; and various

Figure 1: ISDN BRI growth from January 1995 to July 1997



ATM fast packet services, beginning to take hold.

WHICH TRANSPORT TO CHOOSE?

Carriers trying to maximize a broadband investment are faced with a bewildering array of options. Running headlong against SDV is the hybrid fiber-coax (HFC) and cable modem camps, which offes broadcast quality video (including interactive video, video-on-demand and Web surfing) and data in a packetized format using a bus architecture, thereby enabling large numbers of users on a street to share a single transmission, but without the privacy or symmetrical transmission capabilities of switched architecture. Aside from HFC, direct broadcast satellite (DBS) and very small aperture terminal (VSAT) satellite antenna technologies are becoming increasingly popular to distribute video and television to residential and private business users. Then, there are the "last mile" broadband solutions for copper: assymetrical digital subscriber line (ADSL), very high bit rate digital subscriber line (VDSL) and ISDN/digital subscriber line (IDSL) which, when optimized, can pump anywhere from 10 Mbps to 50 Mbps downstream (without tying up switching fabric). These are ideal for some interactive video applications, distance learning, conferencing, shopping, and on-demand broadcasts of movies and other programs.

Carriers trying to maximize a broadband investment are faced with a bewildering array of options: HFC, cable modems, DBS, xDSL...

How do carriers choose a video strategy? The major interexchange carriers (IXCs) already have carved out a lucrative ISDN-based (also T1- and T3-based, on certain occasions) video bridging and systems integration niche while partnering with video conferencing equipment suppliers and, in some cases, incumbent local exchange carriers (ILECs) and competitive LECs (CLECs) for the local wireline portion of a video solution. For example, MCI sells switched 56 and 64K (fractional T1) over LEC-installed ISDN BRI and PRI, enabling aggregated bandwidth up to 384 kbps for near-broadcast quality SDV, principally for multi-point business conferencing with guaranteed bandwidth. MCI calls its bridging concept "the electronic meeting place."

"In the realm of video, our business unit often sells the complete equipment package, so we can provide customers with end-to-end solutions," says Ken Velten, manager of new conferencing technology for MCI. "We resell PictureTel, Vtel and Tandberg [equipment]. Our business customers don't want to be subjected to the quality issues of video over the public Internet." Yet, Vel-

ten says many business users want some type of hybrid or H.323 packetized service to extend the switched video fabric into the campus LAN world.

"If you have campus environments, you have workers throughout who want to jump onto a LAN [for video], and they'll be able to do that with Microsoft's NetMeeting," he says. "Once you go from the corporate Intranet to the public Internet, there are Quality of Service and interoperability issues, but the vendors are working these out and the equipment [is improving]."

Companies such as Intel are producing streamlined PC-based conferencing products such as TeamStation (a Pentium-based PC equipped with Intel's ProShare video conferencing technology) "that don't require five pieces of equipment," Velten says. Like TeamStation, video codecs, speakers and other components, "all can be on one platform so it's as easy to place a video call as a voice call. It's not that easy today."

Many business users today want a hybrid or H.323 packetized service to extend the switched video fabric into the LAN.

Carriers such as AT&T and Sprint are forming strategic alliances with vendors in key vertical industries to develop packetized gateways, electronic prepress and video courier solutions. An example is AT&T's recent alliance with Imation, an imaging company spun off from 3M (St. Paul, Minn.). Sprint has been working with VideoServer and RADVision to develop bridges and gateways for their SDS (also known as "the diamond network"), linking H.323 desktop (packet) video and switched H.320 digital video.

"It's going to be very important to serve corporations and campus building environments, especially companies that have some guaranteed QoS under their own plan or Intranet," says Scott Crowder, technical director at Sprint.

"SDV offered by carriers is something that's ubiquitous in the business community," says Roger Walman, an H320 product manager with VideoServer (Burlington, Mass.). "Products are coming to the forefront very soon that will help users on legacy switched networks to convert to packet...allowing packet network users to conference with people on a switched network through gateways." Walman declined further comment on VideoServer's current involvement in these gateways.

Sprint announced that protocol conversion devices are already in alpha and beta testing stages. Companies such as Intel, RADVision and Accord "will be able to interoperate between H.320 and H.324 by third or fourth quarter of 1998," Holmes says.

The RBOCs themselves seem to have had a more difficult time outlining a

Figure x: copy

Business Sector	Application		Global ISDN Competency
Education	Distance learning Information Video (interactive/broadcast)		Group video
Entertainment	Video and audio clip distribution Product review		Desktop video and data collaboration
Finance	Payment transfer Personal finance Service info	Market Info Telecommuting Remote Expert	Executive video
Insurance	Sales info updating Application/customer	Info databases Agent info exchange	Digital audio broadcasting
Manufacturing	Product info CAD/CAM	Document distribution Dealer info networks	Electronic courier
Service	Customer service Ordering	Document distribution Telecommuting	Remote Access to corporate resources critical database transfers
Medical	Image distribution Record Updating	Distance learning Remote consultation	
Publishing	Full color image distribution Document distribution/production review		

Source: AT&T

coherent video strategy. Almost all RBOCs agree in principle that driving fiber deeper into the network, and closer to residential and business customers, will be essential for high-speed broadband networks of the near future. Yet most Bells—Bell Atlantic excepted—have apparently refrained from taking the plunge.

U S West and SBC/Pac Bell, for example, originally planned substantial HFC and FTTC deployments intended for broadband residential services, and both RBOCs abandoned their original plans. According to a U S West Communications source, a test of an HFC system in Omaha, Neb., to satisfy an early Federal Communications Commission (FCC) rule for video dialtone (to do interactive video and telephony) eventually led to an application to build out an extensive FTTC network in Denver. But plans were scrapped because "the technology and cost points weren't quite there at the time [1994 to 1995]." The spokesman did not rule out future reconsideration of the fiber/SDV option.

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H ◯ MSO (Two or more Cable TV Systems)
I ◯ Independent Cable TV System
J ◯ Cable TV Contractor/Engineering Firm
K ◯ Other Cable
L ◯ Competitive Access Provider (CAP)
M ◯ Telecommunications Reseller
N ◯ Internet Service Provider/Commercial Online Service Co.
O ◯ Systems Integration/Outsourcing
P ◯ Other Carrier
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3. Which of the following describes your title classification? *(Fill in **ONE** only.)*

11 ◯ **Technical Mgmt.** (Engineering VP, Director or Mgr.; Technical VP, Director or Mgr.; Network VP, Director or Mgr.; Plant Mgr.)
12 ◯ **Engineering** (Network Designer, Engineer, Technician)
25 ◯ **Data Communications/Digital/IS/MIS Mgmt.** (Data Communications, Digital, I/S VP, Director or Mgr.)
13 ◯ **Mgmt.** (VP, General Mgr., System Mgr., Mgr., Director)
3 ◯ **Corporate Mgmt.** (Chairman, Owner, President, Partner, Executive/Senior VP/Director, Treasurer, CFO, COO)
4 ◯ **Legal, Financial, Regulatory or Processing Services** (Director or Mgr. of Rate Planning & Administration, Service Costs, Methods)
5 ◯ **Personnel & Administrative Services** (Director or Mgr. of Training, Safety, Security, Buildings & Land, Supplies & Distribution)
16 ◯ **Sales/Marketing** (Sales or Marketing VP, Director, Mgr., Representative)
20 ◯ **Purchasing** (Purchasing, Materials, Contract VP, Director or Mgr.)
7 ◯ **Other** (Co. Copies and Other Titled and Non-Titled Personnel)

4. Which of the follow equipment/services do you purchase, recommend, specify, approve or otherwise influence the purchase of? *(Fill in **ALL** that apply.)*

A ◯ **Wireless/Cellular/Mobile/PCS Equip./Services**
B ◯ **Central Office Equip./Services** (CO Switching Equip. [digital, ATM], Programmable Switches, Operations Support Systems, Workstations, CO Test, Hardware, Frames)
C ◯ **Transmission and Broadband Distribution Equip./Services** (Digital Loop Carriers, Sonet, T1, Microwave, Satellites, Digital Cross Connects, Amplifiers, Passives, Cable, Long Haul Transmission Systems, Loop Distribution and Electronic Systems, Multiplexers)
D ◯ **Cable/Video/Multimedia Equip./Services** (Headend Equip., Antennas, Switches, Receivers, Studio Equip., Audio Processors, Fiber/Coax Systems, Network Mgmt., Video Servers, Video Operations Support Systems, Set Top Equip.)
E ◯ **Customer Premises, Broadband Subscriber Equip./Services** (PBXs, Station Equip., ACOs, Videoconferencing, Remote Controls, Converters)
F ◯ **Outside Plant and Construction Equip./Services** (Pedestals, Vehicles, Towers, Tools, Enclosures)
G ◯ **Data Communications/MIS/Network Mgmt. Support Equip./ Services** (including LANs, WANs, & Network Software)
H ◯ **Power & Protection**
I ◯ **Test & Measurement**
J ◯ **Other** *(please specify)* _____
K ◯ None of the Above (A–J)

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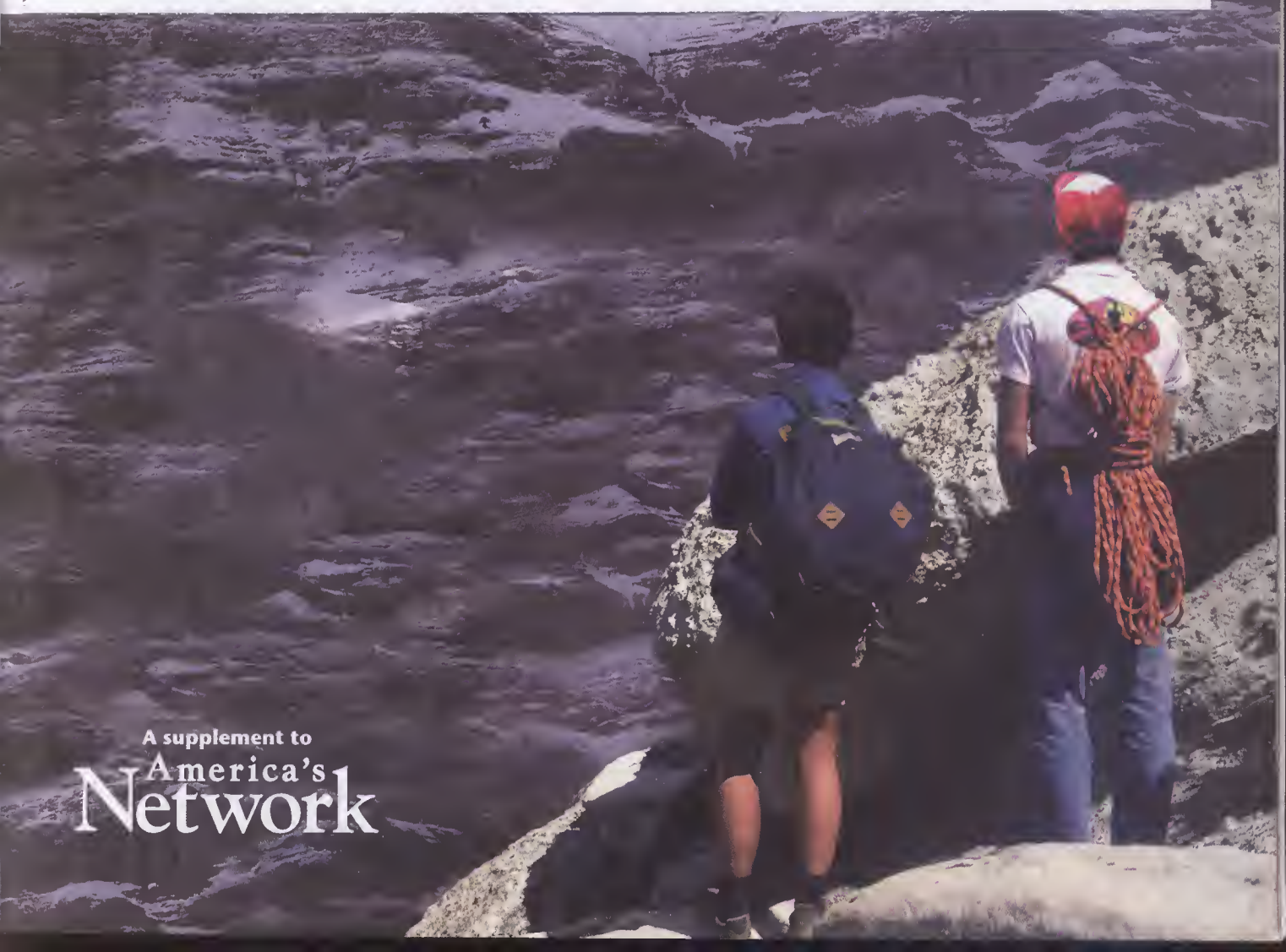

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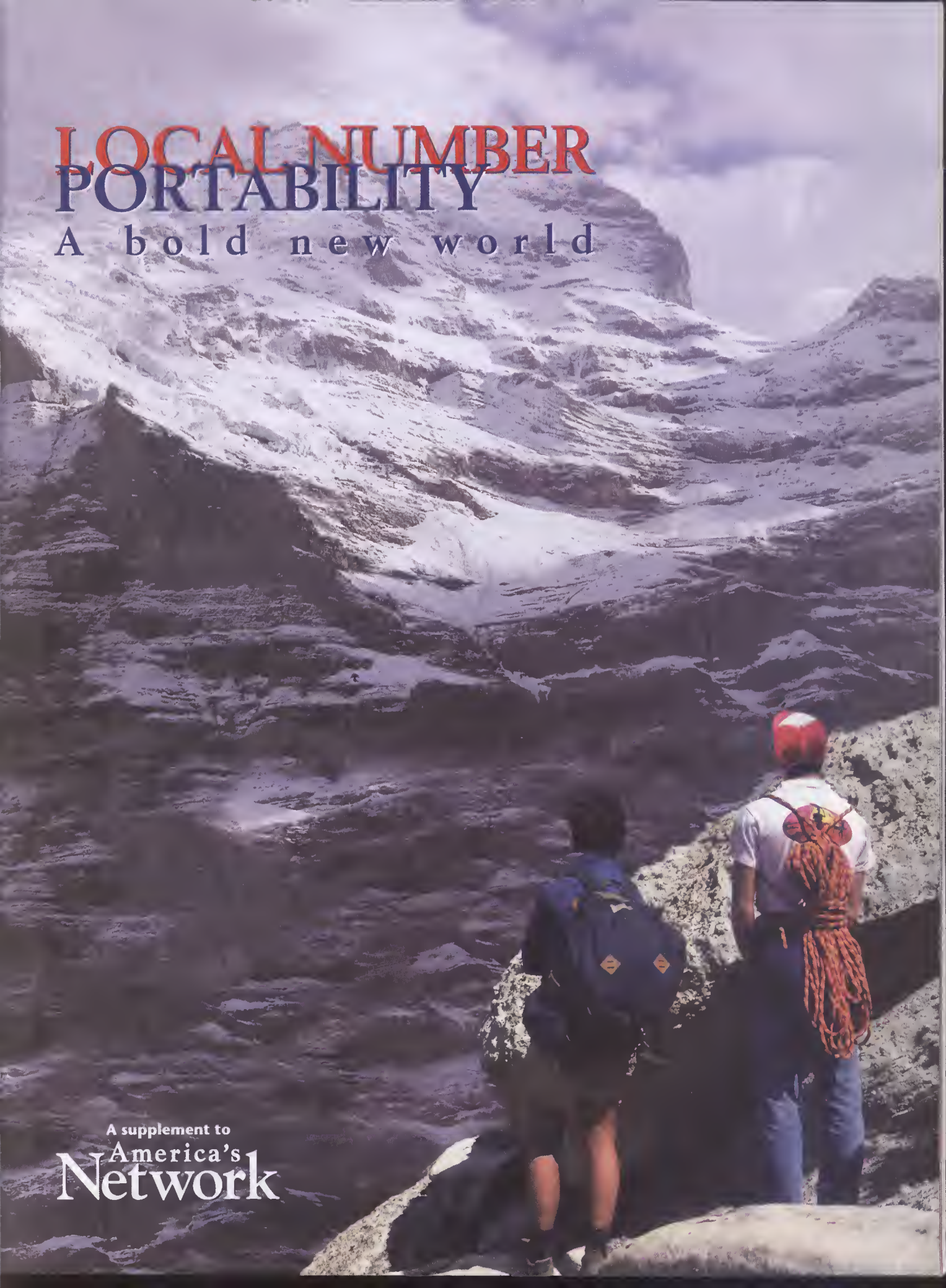
LOCAL NUMBER PORTABILITY

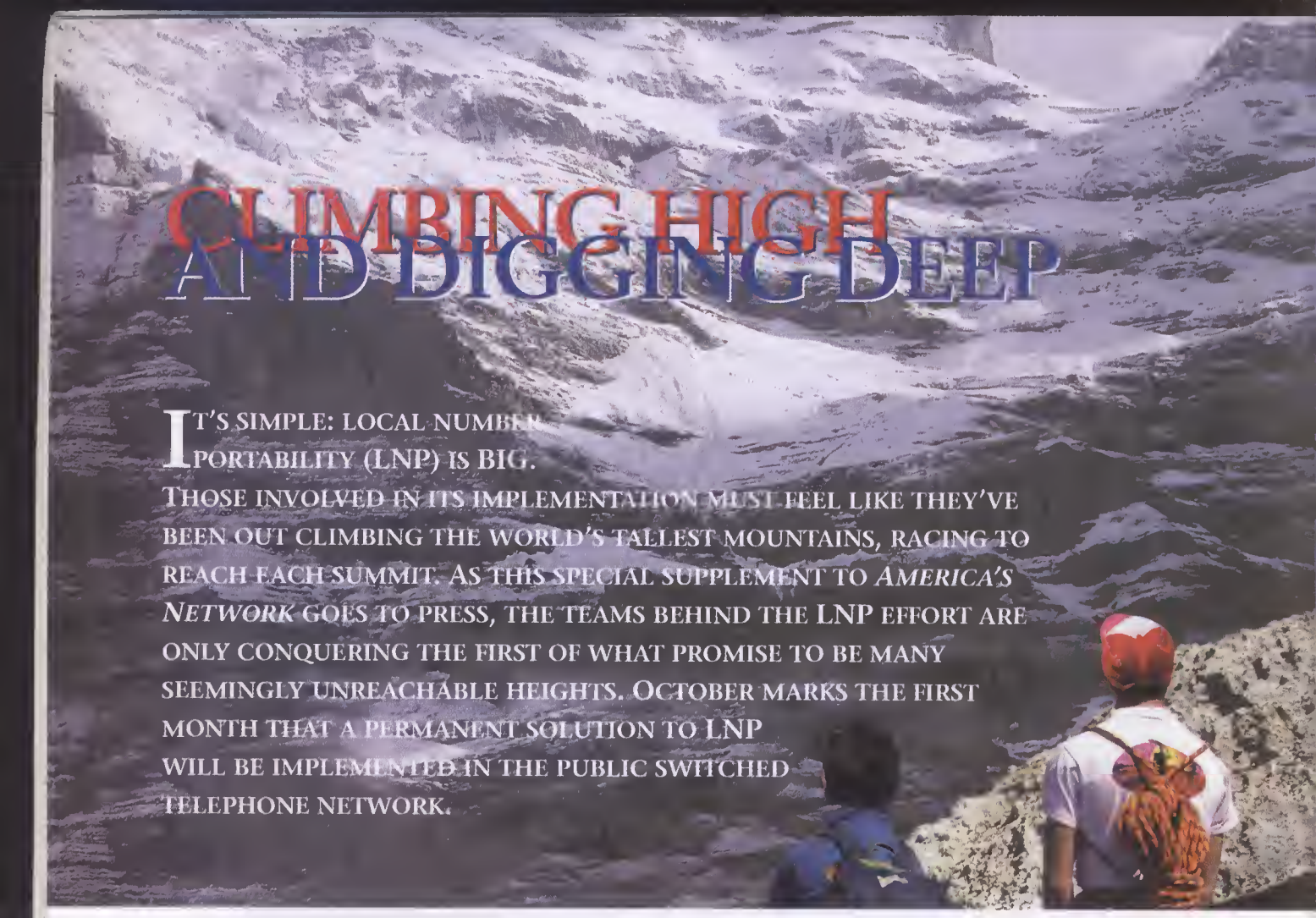
A bold new world



A supplement to America's Network

CLIMBING HIGH AND DIGGING DEEP

IT'S SIMPLE: LOCAL NUMBER PORTABILITY (LNP) IS BIG. THOSE INVOLVED IN ITS IMPLEMENTATION MUST FEEL LIKE THEY'VE BEEN OUT CLIMBING THE WORLD'S TALLEST MOUNTAINS, RACING TO REACH EACH SUMMIT. AS THIS SPECIAL SUPPLEMENT TO *AMERICA'S NETWORK* GOES TO PRESS, THE TEAMS BEHIND THE LNP EFFORT ARE ONLY CONQUERING THE FIRST OF WHAT PROMISE TO BE MANY SEEMINGLY UNREACHABLE HEIGHTS. OCTOBER MARKS THE FIRST MONTH THAT A PERMANENT SOLUTION TO LNP WILL BE IMPLEMENTED IN THE PUBLIC SWITCHED TELEPHONE NETWORK.



If you think about it (and, really, most people don't), the process of making a simple voice phone call across the public network is extremely complex. Whenever I begin to explain the nuts and bolts of a phone call to a "layperson," the eyes widen and the jaw drops.

Today, the process of actually completing a call does not cause people to faint from disbelief, as they did when Bell and Watson first exhibited the wondrous powers of telephone transmission to a crowds of curious onlookers. However, those who have been working to implement number portability are probably feeling a bit woozy by now. The more you delve into LNP, the more the ground beneath you seems to wobble.

Nevertheless, the telecommunications industry is moving forward with its bold plan to level the competitive playing field by freeing telephone numbers:

- From a customer's service provider and the central office switches to which they have been bound since the creation of the network;
- From the geographic area or rate center in which they were originally located; and
- From the services which they originally supported.

This report focuses on the issues—of which there are many—surrounding the implementation of service provider portability. We'll examine how LNP works; the impact of LNP on the existing public network infrastructure; the cost of LNP and who will pay for it; how service providers and regulators will ensure that LNP is working properly to begin with and on an ongoing basis; the potential for slamming; and the future of number portability as we stand on this first mountain peak .

If the industry is successful in implementing Phase I of this ambitious endeavor, reasons to celebrate will be endless. If it is not successful, however, the repercussions could be endless.

The implementation of LNP is one of the big moments in the history of the telephone. It ranks among the biggest events of all, comparable with uniting the disparate telephone companies that formed after the telephone was invented so that everyone with a telephone could talk to one another, and with divestiture of that monopoly to reinsert the benefits of competition into the industry. Number portability aims to increase the competitive benefits that consumers and service providers alike have realized since divestiture.

This month, the teams of people who have been conquering every mile toward the first summit can look back across the ground they have covered with a sense of accomplishment. But they must also dig deep inside and summon up the resources they will need to reach their next goal—rolling out LNP in the rest of the nation's top 100 metropolitan areas. ■

This special supplement was compiled and authored by AN *senior editor Annie Lindstrom with assistance from freelance telecom writer Andrew Braunberg. Design by* AN's *art director, Jon Fraze.*

The abc's of LNP

Everything You Ever Wanted to Know About Number Portability, But Were Afraid to Ask*

Unless you already know an awful lot about how calls are processed and delivered today, you'd probably better not ask how they'll be processed and delivered in a local number portability (LNP) environment... unless, of course, you are willing to risk death by acronym overdose.

Those without fear can consult two pages on the World Wide Web: http://www.ported.com or http://www.fcc.gov

Those who would rather nosh on the concept before committing to the whole enchilada can start here.

In a nutshell, LNP amounts to two things:

1) Service providers will "port" existing telephone numbers to new facilities with the help of new equipment in their own networks that will work with similar equipment in regional number portability administration centers (NPACs).

2) Central office (CO) and tandem switches no longer will be able to use only a telephone number's NPA-NXX code (area code and exchange code) to determine where a call should be delivered. Routing information for ported numbers will be contained in LNP databases, which must be queried when any call is made to an NPA-NXX that contains a single ported number.

Porting a number

There are two NPACs. The Lockheed Martin NPAC is partitioned to serve carriers in four regions. The Perot Systems NPAC is partitioned to serve carriers in three regions. NPACs help carriers synchronize the porting process and are the ultimate source of porting data for those carriers.

Here's how the porting process works (see Figure 1):

1) Carrier A wins business of Carrier B's customer. Carrier A enters porting information into its operations support systems (OSSs).

2) Carrier A's provisioning system feeds porting information to Carrier A's local service order administration (LSOA) system.

3) Carrier A's LSOA forwards a porting request to the NPAC SOA, specifying the date and time porting should occur.

4) NPAC SOA notifies Carrier B's LSOA of porting request.

5) Carrier B's LSOA informs Carrier B's OSSs of porting request.

6) Carrier B notifies customer of porting request to validate its legitimacy (not required, under consideration by some carriers).

7) Carrier B's LSOA tells NPAC SOA it has received porting request and confirms date and time of change.

8) NPAC SOA tells Carrier A's LSOA that Carrier B has acknowledged request and confirmed arrangements.

9) NPAC SOA transmits porting and scheduling information to NPAC service management system (SMS).

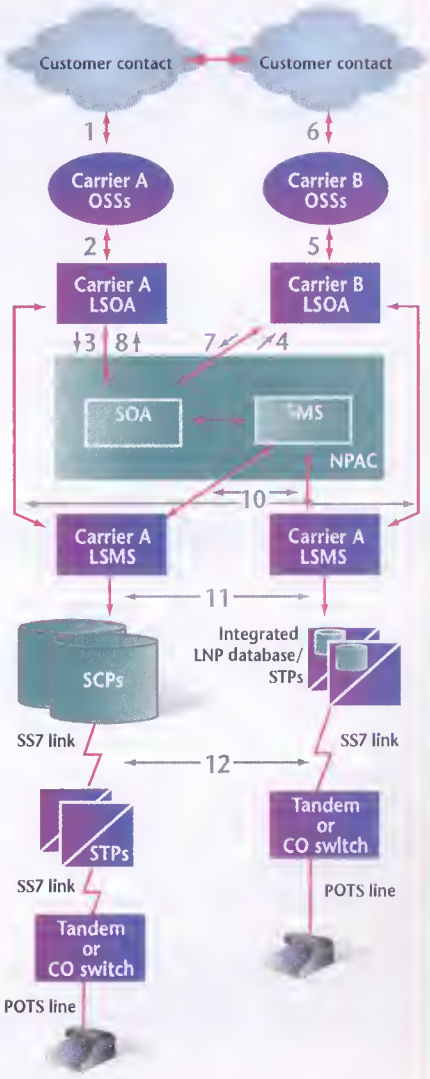
10) Number is ported. NPAC SMS immediately downloads the porting information, including local routing number (LRN) assigned by Carrier A, to all the local SMSs (LSMSs) it serves. Most carriers' LSMSs will pass the information to their LSOAs, which will pass it to appropriate OSSs.

11) LSMSs download porting information and LRN to LNP databases, which can be service control points (SCPs) or signal transfer points (STPs) with integrated LNP databases.

12) All calls made to an NPA-NXX that contains a ported number will require an LNP database query. Switches belonging to the second-to-last carrier delivering a call (N–1 carrier) will query LNP databases via signaling systsem 7 (SS7) links to obtain LRN and then route the call accordingly.

story continues page S4

Figure 1: Porting a number



Just who the N–1 carrier is will be determined by the central office switch (see Figure 2).

Carriers are relying on two different LNP database architectures to store and dispense the LRN associated with the dialed telephone number—an STP/SCP configuration or an STP with an integrated LNP database (Figure 1, Step 12).

At press time, some carriers were still weighing the advantages and disadvantages of each architecture, while others had chosen one or the other, or a mixture of the two, to get the LNP ball rolling in their networks.

Although both solutions are acceptable, factors affecting carriers' decision making processes include striking a balance between cost and flexibility, while taking into consideration their embedded base of intelligent network equipment and SS7 links as well as their plans for the future, according to Walter Johnston, vice president of service development for Bell Atlantic.

Carriers are relying on two different LNP database architectures to store and dispense the LRN associated with the dialed telephone number—an STP/SCP configuration or an STP with an integrated LNP database.

The traditional STP/SCP architecture had been adopted by GTE, Southwestern Bell and U S West, which had selected Bellcore's second-generation ISCP as their LNP database platform; and by Ameritech and BellSouth, which had chosen the Lucent Technologies Service Control Point.

"Using the STP/SCP configuration will give us more flexibility in terms of data distribution and data management," says Jerry Chen, research manager of science and technology for BellSouth, which is using the Lucent Technologies Service Control Point as its LNP database. "It may have a little bit of an impact on performance, because queries have to go through external links from the STP to the SCP database. But we think that, in the long term, the flexibility that SCPs provide will help us make LNP part of future service offerings."

A new tack

Two STP vendors, DSC Communications and Tekelec, are inviting carriers to take the SCP out of the LNP querying process altogether by expanding the database capabilities of their STPs. LNP service bureau Illuminet, Bell Atlantic and Nynex (before it officially merged with Bell Atlantic) decided to deploy Tekelec's Eagle LNP integrated solution in their networks. At press time, DSC had not yet announced any customer agreements for its INfusion STP with LNP.

Lower cost and high transaction rate capability of the STPs outweighed the benefits of flexibility offered by SCPs, says Bell Atlantic's Johnston. "The cost savings on equipment, trunks, SS7 links, floor space and related ancillary savings the Tekelec solution offered us were significant for a company of Nynex's size," he adds.

Illuminet also cited cost as a factor. "We had just deployed a brand new pair of Tekelec STPs in our network. The ramp up to get the database on line was minimal compared to what it would have been to put in a whole new pair of SCP-based machines," says Maggie Lee, senior network engineer for Illuminet.

"We can deploy a lot less infrastructure and meet a lot more growth with the integrated STP solution than we could with SCPs, because SCPs have a much lower transaction-per-second capacity," adds Rebecca Stillings, number portability product manager for the service bureau, which will be processing LNP queries for carriers nationwide. ■

Figure 2: Call delivery

All scenarios—816-724-2245 changes service providers from LEC 1 to LEC 2; and NXXs 724 and 662 are ported.

Scenario 1:

1) 724-3348 calls 724-2245.

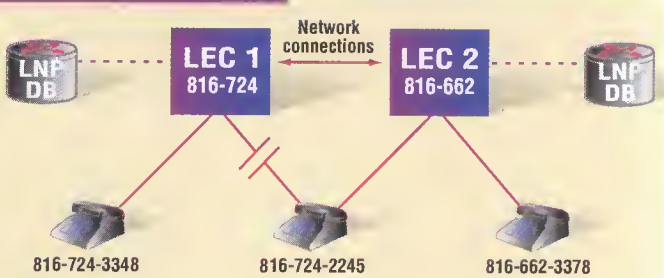
2) 724-2245 can't be found on LEC 1's switch, so query is launched to LEC 1's LNP database. The LRN returned is 816-662-XXXX.

3) Call is routed to LRN 816-662-XXXX on LEC 2's switch and call is terminated to 724-2245.

Scenario 2

1) 662-3378 calls 724-2245.

2) Number is found on LEC 2's switch and call is terminated.



Scenario 3

1) 724-3348 calls 662-3378.

2) The switch tables indicate that 662 NXX is portable and query is launched to LEC 1's LNP database to get the LRN.

3) Because the number is not ported, the dialed number is returned, not an LRN, and the call is routed normally.

Source: North American Numbering Council

Isn't it ironic...

How many things will have to change so one thing can stay the same?

It's a shame that Rube Goldberg isn't alive. The cartoonist, famous for his drawings of devilishly complex and impractical inventions, could have provided some excellent pictorial commentary on the numerous and expensive network modifications LNP requires, as well as the circuitous signaling needed to complete a ported call—all of which must be done just so a customer can hang on to a 10-digit telephone number .

Perhaps Goldberg also could have provided a few helpful tips for carriers struggling to determine the depth of LNP's impact on their networks. Adding the equipment and software that facilitates the actual porting of a number when a customer defects to another facilities-based carrier has been labor-intensive, indeed.

But the work hasn't stopped there. Carriers have had to take a magnifying glass to their existing network infrastructures, operations support systems (OSSs) and work processes to determine how, and to what extent, LNP will affect them. A substantial number of existing systems and processes have been utterly dependent on NPA-NXX codes to date; so reengineering them to support LNP has taken as much—and in some cases even more—resources than it has taken to put in what's new.

"The biggest challenge for us is to make the necessary changes to internal processes and systems to accommodate LNP and, up front, they were the hardest to quantify," notes Scot Lewis, senior manager of LNP planning and implementation for WorldCom Inc.

"So much attention has been paid to how to make things in the network work that those kinds of things are moving along well," comments Roger Werth, director of network architecture planning for Cincinnati Bell. "However, all the back-end systems, business support systems and OSSs are not nearly as far along. That is where we are finding our biggest headaches.

"The question is, are companies prepared to totally replace some or all of their systems or apply Band-Aids to their legacy systems?" Werth adds.

All ripped up

Bellcore, the company with the mother lode of legacy OSSs installed in the networks of the regional Bell operating companies (RBOCs), delivered updated LNP software to its customers in May and July, according to Janice Housten, principle solution architect for Bellcore. Over the past two years, 300 to 500 Bellcore employees have devoted their time to writing more than 1 million lines of code to update its legacy and newer MediaVantage line of OSSs.

"It's been such an underlying assumption that we know where a number will be working based on the number that's been assigned to a customer," Housten says. "With LNP, all those assumptions are ripped up and turned on their heads."

For example, Bellcore's provisioning systems—Service Order Activation Controller (SOAC) and MediaVantage/MediaPulse/Delivery—previously used a telephone number's NPA-NXX to make physical equipment assignments. Now, they will use a cue called an exchange key. Bellcore also defined an open interface that will shuttle information between a carrier's local service order administration (LSOA) system and Bellcore's provisioning systems, says Housten.

In addition to upgrading their legacy systems, carriers must create a tremendous amount of new methods and procedures to survive in an LNP environment, Housten continues. Carriers will take orders for services differently, so order-takers and customer service representatives need training to understand the way things should work in the new environment.

"The opportunities for failure have dramatically increased," she notes. "A ported number requires OSS changes so you can display that information and not erroneously say that phone number is not working, or call it a spare just because it's been ported to a competitor."

Most OSS databases will need to expand to accommodate all 10 digits of a telephone number so they can function properly in an LNP environment. For

example, systems that previously used only the NPA-NXX to find the switch belonging to a particular telephone number can no longer do so, observes Jerry Chen, research manager of science and technology for BellSouth. The RBOC examined 200 of its OSSs and determined that half of them needed some type of modification, be it little or substantial.

Software is not the only piece of network infrastructure that needs attention. Some central office (CO) switches are going to need a boost in processing power, according to Bell Atlantic's Allen.

"Say someone ports their number inside of a BellSouth rate center because they are moving from the north side of town to south side of town," Chen explains. "If they get service from a different switch, and we don't update the testing system, we will end up testing the wrong switch and we'll get an incorrect test result."

Likewise, someone who ports out of an incumbent local exchange carrier (ILEC) switch to a competitor's switch, moves within the rate center and later ports back to the ILEC, but is served out of another switch, may be all right architecturally, but probably has created some problems for the ILEC's OSSs, says Bob Allen, director of LNP implementation for Bell Atlantic.

"It's unbelievable what we've gone through to get all the various groups involved to try to figure out the impacts of all of these different scenarios," Allen says. "There is a tremendous combination of things that could happen that you've got to be able to plan for."

Impact of LNP 10/1/97 to 3/31/98

Company	Switches upgraded	NXXs with potential to port	SS7 links added
Ameritech	175 +/-	1,000	400 +/-
Bell Atlantic	218	1,554	558
BellSouth	23	600 to 700	(17% increase)
GTE	100 +	800	N/A
Nynex	120	1,285	1,272
Pacific Bell	115	800 +	310
SWBT	126	580 +	164
Teleport	10	420	0
U S West	98	486	75
WorldCom	10	151	38 to 44 (T1 lines)

Important details—such as registering a ported customer with the appropriate E-911 provider, directory assistance provider and telephone directory publisher—will be the responsibility of the new service provider, points out Patrick Luczak, director of product management for Evolving Systems Inc., maker of LSOA and LSMS systems. Next March, Evolving Systems plans to roll out its 21st Century portfolio of OSSs, which it created specifically for the LNP environment.

What's my line?

Just knowing what telephone numbers belong to a certain carrier also will be a challenge. Although the North American Numbering Council (NANC) will continue to allot telephone numbers in 10,000-number blocks to carriers, their OSSs no longer will be able to assume that all of those numbers belong to the carrier. These OSSs will have to be modified to keep track of telephone numbers individually, rather than in groups, adds Luczak.

Until location portability is introduced, ported numbers that are disconnected will "snap back," after an appropriate aging period, to the carrier that has been assigned that NXX, according to the NANC's architecture and administrative plan.

Billing systems also need to be modified and "beefed up." Carriers that want to charge other carriers for default routing will have to be required to keep track of the carrier for which a query is performed, so that carrier can be billed accordingly. Carriers also will need to keep track of queries made for other carriers that have entered into prearranged agreements with them, says Frank Salm, product marketing manager for AG Communications Systems.

And that's not all. In addition to billing for queries, local providers will need to bill one another for terminating each other's local calls. While ILECs are fairly well-equipped to do this, new entrants probably are not. Some ILECs may offer to keep track of termination billing for these new entrants—for a fee, Luczak says.

Interexchange carriers (IXCs) that previously used NPA-NXX codes to drop off calls to local provider's tandem switches (and let the local carriers handle it from there) will have to make new interconnection arrangements with old and new local service providers, says David Heath, senior manager for MCI. The IXC had to upgrade 80 of its major OSSs to support LNP, he notes.

Software is not the only piece of network infrastruc-

ture that needs attention. Some central office (CO) switches are going to need a boost in processing power, according to Bell Atlantic's Allen. To discover which switches need additional power, he says carriers must:

- Pull data manually from the switches to determine what percentage of a switch's central processor capacity is used;
- Estimate how much additional power will be needed in that switch; and
- Make the necessary upgrade.

"Approximately 50 of Bell Atlantic's host switches will require processor capacity upgrades," Allen notes. "That's a major deal."

Nynex, for example, expects to process as many as 12,000 transactions per second on its SS7 network during peak load in New York City, says Lee Smith, senior director of marketing for Tekelec. (The RBOC is preparing for such fire-hose strength messaging by deploying Tekelec's Eagle integrated LNP database/STP. The system supports up to 500 SS7 links.)

That 'new call' smell

It's obvious that carriers and vendors have gone to great lengths to ensure that no stone has been left unturned in finding, fixing and beefing up network elements, OSSs and work processes that will be affected by LNP. What seems to be keeping people up at night is the fact that nearly everything associated with LNP is brand-spanking new. The myriad of new software, new equipment, new players and new processes seems to be giving off a smell 1,000 times more pungent than the air inside a car just driven off of a showroom floor. Carriers, regulators and vendors are breathing deep with anticipation.

"All these changes to OSSs and so forth are things that people hope will enable them to deal with LNP," says Bell Atlantic's Allen. "But really, until these things are delivered and proven, they are making people like me—who are charged with implementing this—very nervous and concerned. This is, by far, the biggest thing the telecommunications industry has ever done." ■

Phase 1 LNP roll out schedule

(FCC and State mandates)

Atlanta
Baltimore/Washington, D.C.
Chicago
Detroit
Gaithersburg, Md.
Houston
Los Angeles
Minneapolis
New York
Philadelphia

Local number portability will be introduced in these 10 metropolitan areas between Oct. 1, 1997 and March 31, 1998.

Signaling system 7 (SS7) networks that connect those switches to the intelligent network (IN) elements involved in processing a call are in no shape to handle the onslaught of traffic generated by LNP database queries, either. The RBOCs, which have anywhere between 2,500 to 4,000 56 kbps SS7 links per company, likely will need to add 800 to 1,000 links to their SS7 networks to support LNP, predicts John Ehrig, senior product manager of Telecom Solutions.

"No one really has a good handle on how fast this is going to roll out or how fast they are going to need all that," he acknowledges, "but I would say most telcos will add 20% to 40% more links to their networks over the next one to three years, no matter how big they are."

All work and no pay?

Service providers have been dashing to deploy LNP by the deadline. But who's going to foot the bill?

Local number portability (LNP) is widely seen as a prerequisite to real competition in the local telephone market. The ante to get into the game is, by most estimates, quite costly for telephone companies that are required to support the capability as well as for those who want to play in the emerging competitive local market.

Nevertheless, it's still not clear just who will pay for the billions of dollars' worth of network infrastructure upgrades and associated administrative chores required to make LNP a reality. Chances are good, however, that a substantial portion of the expenses will trickle down to subscribers—who, ironically, are supposed to benefit most from the competition that LNP enables.

On Aug. 14, the Federal Communications Commission (FCC) issued its Second Report and Order on Number Portability. Although the order contained no ruling on cost recovery, the FCC did agree with the North American Numbering Council's (NANC's) proposal, allowing carriers to charge default-routing fees for unqueried calls. What won't be revealed until the Third Report and Order are:

- Just how much carriers will be able to charge for default routing;
- Who will pay for LNP; and
- What costs will and will not be recoverable.

The categories of cost

LNP costs can be divided into three broad categories—shared, direct and indirect. Shared costs include those associated with constructing and operating the regional number portability administration centers (NPACs). Direct and indirect costs include infrastructure expenditures that are associated solely or partially with LNP.

The administrative processes associated with porting a number—processes that are being overseen and coordinated by the NPACs—are a shared cost. But how will those costs be shared ?

NPAC administrators Lockheed Martin and Perot Systems already have set their prices and will be sending bills to the regional limited liability companies (LLCs) formed by the carriers. LLCs select and manage neutral, third-party NPAC providers. LLCs will bill the carriers according to the rules established in the Third Order and Report on Number portability, according to an FCC source.

Recovering shared and direct costs could be accomplished through usage-based, per line schemes, or per revenue charges, according to the FCC official.

"We tentatively concluded that we would use a net revenue-based allocator to allocate shared costs," the official explains. "Net revenues are gross telecommunications revenues, minus charges paid to other carriers. We asked, but did not conclude, whether or not to do the same thing for direct costs."

The revenue-based method has obvious appeal to new and/or smaller entrants to the local loop market. "We believe the FCC took a very fair and balanced approach by [tentatively] basing shared costs on net revenues," says Fredrik Cederqvist, manager of government affairs for Teleport Communications Group (TCG). "This ensures that each carrier pays according to the amount of business that it has. Therefore, no carriers will be disadvantaged disproportionately by shared costs."

The cost of operating an NPAC in each of the seven created service areas—which follow the borders of the regional Bell operating company (RBOC) original service areas—is estimated to run roughly $25 million per region over a five-year period.

The Price of Portability

Line Item	Estimated Cost
Number Portability Administration Center	$25 million per region over five years
Local service management system and local service order administration system	$500,000 to $2 million each
LNP database	$1 million to $4 million each
Signaling system 7 upgrades	Several thousands of dollars to several millions of dollars per carrier
Local number portability switch software	$250,000 to $500,000 per switch
Operations support system upgrades	$2 million to $20 million per carrier
Employee hours	Unknown

Source: MDF Associates

Although shared costs are substantial, in the long run they probably will represent only a small percentage of the overall price of implementing LNP.

Direct costs are those spent to create an LNP network infrastructure. Direct costs include the service control points (SCPs) or enhanced signal transfer points (STPs) which telcos will use as LNP databases, LNP software upgrades for central office switches, and the ongoing costs of uploading and downloading information with the NPACs. These costs are directly and uniquely tied to handling LNP traffic and adminstration—and the costs of these upgrades can be enormous.

"Installing LNP on switches can cost anywhere from $75,000 to $750,000 per switch," says Frank Salm, product marketing manager of INgage Solutions for AG Communication Systems.

Indirect costs are those spent on equipment that has broader application throughout the network and could provide tangential benefits to the carriers, such as deploying a signaling system 7 (SS7) network.

SBC Communications Inc. has estimated that it will cost its subsidiaries—Southwestern Bell Telephone Co. (SWBT) and Pacific Bell—roughly $1.5 billion to implement LNP, according to a spokesman for SWBT. In filings with the FCC, the RBOCs and GTE have estimated that their direct LNP costs will fall somewhere between $200 million and $700 million per region over five years, according to the FCC. However, the commission official observes that none of the carriers are clear on what exactly they're including in their estimates.

Carrying on...

Needless to say, how to allocate all types of costs and how to allow carriers to recover them are contentious issues between the incumbent local exchange carriers (ILECs), the competitive LECs (CLECs) and the interexchange carriers (IXCs).

The ILECs argue that they have more costs per customer, because their networks are bigger and more expensive to retrofit. The CLECs say that, in comparison, they don't have enough customers over which to spread their costs.

None of the players has yet provided the FCC with a solid formula for representing the cost of implementing LNP on a per-customer basis, according to the FCC official. Each of the players says that Congress has ordered them to be "competitively neutral." Moreover, they say, if they have to bear more than their "fair" share for implementing LNP, they will have to charge customers more, which will then cause their customers to defect to carriers who are paying less for LNP.

The ILECs say new entrants should bear some of the LNP burden, because new entrants are the reason that local number portability is required in the first place. While the CLECs counter that their overall costs are lower (because they have fewer customers), their costs

We don't want any

Wireless providers are kicking and screaming all the way to the LNP starting line.

Just like their wireline counterparts, the Telecommunications Act of 1996 requires wireless carriers to provide local number portability (LNP) to their subscribers and to deliver queried calls to local provider networks for numbers that have been ported. However, unlike their wireline counterparts, wireless carriers have been given relaxed rollout dates, thanks to the Federal Communications Commission (FCC).

In the first rollout phase, wireless carriers must be able to deliver calls to ported numbers anywhere in the nation by Dec. 31, 1998. Nevertheless, beginning Oct. 1, any carrier that delivers unqueried calls to ported numbers will be subject to a default fee levied by the terminating carrier. By June 30, 1999, wireless carriers must comply with the second rollout phase by offering most customers number portability and support for roaming.

Not enthusiastic. Wireless carriers are not the least bit enthralled by their impending LNP deadlines. "Most wireless providers fought LNP kicking and screaming, and were just amazed that the FCC would do such an evil thing to them. But they did," comments Michell Young, an Atlanta-based independent telecommunications analyst.

Bell Atlantic Mobile (BAM) and the Cellular Telecommunications Association (CTIA) have lots of fight left in them. If they have their way, the wireless industry will never have to move into Phase Two.

Several months ago, BAM filed a suit against the FCC, asking the commission to reverse LNP requirements for wireless carriers. This looked like a minor shot across the FCC's bow—until the CTIA joined in suit. The association claims that its membership—which includes the new entrants that are supposed to benefit from LNP's level-playing-field approach—believes that providing number portability to wireless customers is unnecessary, given the current state of the wireless market.

"I am positive that the FCC has overstepped its charge as a result of the Telecom Act," says Fran Malnati, director of government affairs for BAM. "It should not have imposed LNP on wireless carriers. I think it did so with a very minimal record, and a record that did not support whether or not number portability was, in fact, required to add competition to the wireless industry."

BAM believes the FCC should delay requirements for wireless carriers to port wireless numbers until further studies are completed to determine whether the practice is indeed necessary. Plenty of money already has been spent on "a lot" of studies that have proved, at least in the wireless players' opinion, that no one cares what their wireless phone number is, claims Young.

"It was a presumption on the FCC's part that customers, when they do switch carriers, are going to

sidebar continues on page S10

sidebar continued from page S9

want to take their numbers. That is not the case in wireless," Malnati says. "Currently, we have cellular customers changing to PCS providers [even when] they need to switch out the telephone. People do not give out their wireless numbers. And they are not wedded to their numbers in the same way they are to their landline numbers."

In its suit, BAM is attempting only to push back wireless carriers' obligation to port numbers—it is not advocating that wireless should be relieved of all LNP requirements. As landline numbers become portable, BAM plans to deliver queried calls to ported landline numbers.

"Any time our customers make a call to a ported landline number, instead of dropping it into the ILEC's [incumbent local exchange carrier's] network [for default routing], we will comply with identifying where that customer is contracted for local service, and we will route that call to the new service provider," Malnati says.

Doing so will be no small task. Approximately half of BAM's total LNP costs will be associated with implementing Phase One LNP requirements, Malnati adds.

Bad memories. The steep costs associated with porting wireless numbers hinges on an unhappy remnant from cellular's early days: the fact that mobile directory numbers (MDNs) and mobile ID numbers (MINs) are identical.

Wireline carriers use the MDN to route telephone calls that originate in their networks to a wireless telephone. Wireless carriers use the MIN to route and track calls. Once wireless carriers begin to port their own numbers, the MDN will lose its current relevance, because an MDN could belong to any carrier. In effect, wireless carriers will have to double the databases they use to keep track of their customers, notes Malnati.

"For wireless number portability, the MDN and MIN have to be ripped apart," sympathizes Frank Salm, product marketing manager for INgage Solutions at AG Communications Systems. "The MDN will be used for routing the call and the MIN will be used for identifying the actual provider. To facilitate this, switches will have to go through some pretty significant upgrades."

per customer are actually higher than the ILECs' costs.

"Certainly, the intent of Congress would be thwarted if competitive carriers were put in the position of having to pay for upgrades to the ILECs' networks," TCG's Cederqvist contends. That determination, however, will be left to the FCC to sort out.

Indirect costs, on the other hand, may fall more heavily on new and smaller carriers. ILECs and the incumbent IXCs already have existing intelligent network (IN) components that can be used to support LNP, and they have pervasive SS7 networks. Many new entrants in the local exchange, as well as wireless players (see sidebar), do not.

Because carriers can use IN and SS7 networks to offer a variety of revenue-generating services, they are considered an indirect cost associated with LNP. The general consensus in the industry is that carriers must deploy these networks eventually—regardless of LNP mandates—because of the need to provide non-switch-based differentiated services in an increasingly competitive marketplace. How much, if any, indirect costs carriers will be able to recover has yet to be determined.

Don't lean on me

The high costs associated with LNP, as well as the need to size carrier networks properly based on nothing but estimations of traffic volume, have many ILECs worried about "call dumping." Incumbent local carriers are concerned that some carriers may drop unqueried calls into their networks, because of network failure or neglect—willful or otherwise.

FCC rules require the next-to-last carrier to query a call to a ported number; in other words, the N-1 carrier must perform the querying. In the case of a long distance call, the IXC must query its LNP database to determine which LEC should receive the call. For local calls, the originating carrier is the N-1 carrier.

Incumbent local carriers are concerned that some carriers may drop unqueried calls into their networks, because of network failure or neglect—willful or otherwise.

If an IXC delivers an unqueried call to an LEC, the local carrier's network will assume a terminating switch destination from the phone number rather than from the local routing number (LRN), which should have been obtained by a query. Unqueried calls will be default-routed to the switch that the number terminated on before it was ported; that switch will have to send up a query to to its LNP database to get the LRN before the call can be delivered properly. Unless the ILEC has a prearranged agreement with carriers that deliver unqueried calls to it, the ILEC will be stuck with the cost of forwarding the call and any resulting LNP network congestion.

Southwestern Bell and Pacific Bell have filed proposed tariffs with the FCC that anticipate and try to dissuade this type of activity by charging a fee for dumped calls. For example, Southwestern Bell has proposed to charge 0.6 cents to perform a default query—twice the 0.3 cents it proposes to charge for a prearranged query. The tariff also calls for a 74-cent-per-month, per-line charge on the telco's local exchange and resale customers to cover the costs of implementing LNP. ■

No warning signs

How will carriers know when something breaks?

It's taken a lot of teamwork to roll out local number portability (LNP), but it likely will take even more to see that LNP operates properly and doesn't launch some customers into the "Telecom Twilight Zone."

It's possible, for example, that although a customer who ports his telephone number could make calls easily, he may not be able to receive any calls. If this customer normally does not receive a great amount of calls, it might take awhile for him to figure out that it's been some time since he heard his telephone ring. If he complains to his old carrier, he may be told "that's not our problem; you'd better call your new carrier." Although a worst-case scenario, someone who's been slammed by a local provider might not even know the name of his new carrier, much less have proper contact information.

If it's broke, fix it—soon

While it may be tempting to pass the buck, especially when an ex-customer calls for help, it's probably not a good way to do business in the post-LNP world. Determining whether something is broken, what the problem is and to whom it belongs should be of paramount importance to carriers. Those that spend too much time pointing their fingers at one another could lose the trust and business of customers. Consumers and businesses will be receptive to carriers that come a-courting them—especially if they

- Say they know what the customer's particular problem may be; and
- Promise that, no matter whose fault it is, they will do whatever it takes to fix it.

Carriers with the tools to peer into their own signaling system 7 (SS7) networks—which, aside from customer complaints, will be the barometer of an LNP network's health—will be able to determine when a fault is their own and when it is not. This is the first step toward fixing any problem: determine who's responsible for it.

"Until you've established who owns a fault, you are very unlikely to actually resolve it. So there is a real quality of service issue," says Gary Avery, advanced intelligent product product manager for Hewlett Packard's (HP's) Telecom Systems division. "A customer might perceive that an operator is delivering poor service. The actual problem may lie somewhere else, but until that carrier is able to 'accurately finger point' at a third party, the customer will only perceive that there is a problem and could port to another carrier."

Tools being used

Carriers are looking to use network-wide SS7 surveillance systems, such as HP's acceSS7 and Inet's GeoProbe in combination with newly introduced LNP software applications, to glean from their SS7 networks the information they need to locate and fix LNP problems. These non-intrusive surveillance systems can pull LNP-related SS7 data directly off of signal transfer points (STPs) and send the data to a centralized network management center for further analysis.

"The equipment we would like to add to our network will give us network-wide protocol monitoring from a central location," says Mike Pruitt, staff manager of operations for Illuminet. "At our center, we currently call out to a site and ask them to put a protocol monitor on it." That's going to be a thing of the past, he says, because in the future technicians will use computers to click and drag and drop a link within a box, and then determine the type of protocol they are looking at, whether it's failing or not, and whether they see the query and response as they should be.

Although the systems are expensive—GeoProbe costs between $5,000 and $10,000 per SS7 link, depending on the applications a carrier requests and the processing power needed to support them—they'll be worth the investment, according to Kevin Keough, vice president of new business development for Inet. Carriers are absorbing the cost, because they realize they cannot cost-effectively keep up with predicted LNP-related SS7 network growth by merely adding staff and using tools that have limited scope, he adds.

"We will give them a tool they can use to maintain LNP and demonstrate proof and performance of LNP," Keough says. Carriers then can show the FCC and other regulators that "99.99% of their LNP translations are being done correctly" and that "they aren't dropping their competitor's calls because they want their customers to get mad and change carriers."

Cincinnati Bell plans to use its newly purchased GeoProbe system to trace calls when a customer reports that his phone is not ringing, according to John Howison, specialist-technical support for the carrier. "I want to see all call-related information on one form, including my TCAP [transactional capabilities application part] messages," he notes.

Should a competitor's technician claim that Cincinnati Bell is not delivering calls to his network, Howison plans to use GeoProbe to determine whether the initial address message is being sent to the competitor's network. If the surveillance system verifies that Cincinnati Bell is delivering the message, Howison will ask the technician for a purchase order number before he con-

tinues to work on the problem. "I want to be able to charge for my time, because, obviously, I am working on a problem that is in their network. The GeoProbe will let us do that," he says.

Howison plans to use the system's performance monitoring package to gather statistics that reveal how many calls are completed on Cincinnati Bell's network and their duration. He also plans to use it to measure the bandwidth that LNP consumes on his network's SS7 links. (Howison added that he would like to see Inet create a user's group so he can learn even more ways to use the system.)

Although tools that give carriers a network-wide view will play a major role in helping them monitor and maintain LNP, more specialized tools will be useful as well.

"I'm going to use my [Tekelec] MGTS in the lab as a call generator to make sure that my LNP database [and subsequent software releases] will support the amount of traffic the vendor says it will support," Howison says. "I can start breaking some links, remove what is supposed to be a redundant processor and bring it to its knees and see what it will run. That way,we can get a little bit more of a 'warm and fuzzy' feeling that this is all going to work."

A message generator traffic simulator (MGTS) upgraded with LNP software can be used to launch test calls to specific numbers and monitor a call's progress through the network, adds Dan Bantukul, MGTS product manager for Tekelec. "The problem comes in when you try to test a number that has been ported to someone else's network, and you don't have access to the other end," he says. "You have no way of knowing whether the call is terminated or not.

"I can make sure that the response from the database has the right local routing number and called number in it," Bantukul continues. "When I send that call across the gateway to the other network, the only thing I can do is assume that the other network is handling the call correctly."

Bantukul recommends carriers use a tool such as the MGTS to perform late-night auditing of their LNP networks, as errors can be introduced at almost any time or place. "Auditing should be done every day in the early phases of LNP," he cautions. "One day, a carrier can enter new data and everything may work fine, and one day a new software upgrade could be installed and something will quit working. Periodic audits will help catch those kinds of errors."

Sort and store

All of these tools allow carriers to store SS7 data and examine it for clues to specific problems. How much data carriers will want to store, and precisely what data will be of interest to them, is still unknown. "Our system can do millions of things, but each customer only cares about a few hundred," Keough acknowledges. "Most want to do reconstruction of transaction and trace transactions and paste them back together."

The only limit on how much information you can store is how much storage you want to buy, he adds. "Once they get LNP up and running, the carriers are going to realize that they don't necessarily have to capture every bit of information. They will begin to see some trends, and they will be able to set up some filters and criteria that will cut down on their having to look at everything." ■

ATIS alliance to test LNP

Several carriers are taking testing up a notch, and are banding together to test LNP at a network level.

The Alliance for Telecommunications Industry Solutions' (ATIS's) newly formed Internetwork Interoperability Test Coordination Committee has gathered funds from the industry's largest service providers and equipment suppliers—up to $75,000 from some participants—to conduct LNP testing from Oct. 13 to Nov. 7.

"The Federal Communications Commission's Network Reliability and Interoperability [council] recommended that ATIS test LNP by the third quarter of this year," notes Harold Daugherty, director of industry forums for ATIS. "We are going to miss that goal by a couple of days."

Bellcore will provide overall coordination and hubbing facilities for the testing initiative at its Red Bank, N.J., location. Other participants include Bell Atlantic, GTE, Nynex, U S West (which will configure its network to look like a competitive local exchange carrier's if one does not join the project), as well as DSC Communications, Lucent Technologies, Nortel and Tekelec, to name a few. The group will examine:

- The querying process;
- Multiple SS7 link failure;
- SS7 network overload;
- Signal control point overload;
- Call completion under persistent congestion;
- Incorrectly coded calls entering the SS7 network; and
- Looping of signaling messages.

"Until people get comfortable with LNP, this committee is a place where the industry can voice its concerns," Daugherty says.

The committee will decide whether further testing is in order after these tests are completed. Preliminary analysis of the results is slated for delivery to the industry on Dec. 5, with a final report on Jan. 19. Test scripts developed by the group and their outcomes will be included in the final report.

Local Number Portability. Will you be ready in time?

Name: _____ Title: _____

Company: _____

Address: _____

Phone: _____ Fax: _____ e-mail: _____

1) Are you a Telephone Operating Company? Yes ☐ No ☐

Other _____

2) What Type? (Check all that apply)
Wireless ☐ ILEC ☐ CLEC ☐ IXC ☐ Other _____

3) Have you chosen a Local Number Portability solution? Yes ☐ No ☐

If so, what? _____

4) Are you planning to deploy LNP in the next 12-18 months? Yes ☐ No ☐

5) What size is your network? (Subscribers, switches) _____

6) Would you like to receive TEKELEC product information? Yes ☐ No ☐
EAGLE STP/LNP Integrated Solution ☐ MGTS Diagnostics ☐

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Un-called-for switching

Will LNP open the door to slamming?

Competition in the long distance arena has been good for business, but it has produced one side effect that most carriers and consumers could live without—slamming. Local number portability makes it easy for consumers to switch carriers, because they get to keep their number. That fact likely will not be lost on the unsavory crowd that has been reaking havoc in the long distance world. *America's Network* asked Federal Communications Commissioner Susan Ness to talk about actions the commission is taking to stamp out slamming, especially with LNP on the horizon. An edited version of that conversation follows.

America's Network: *The administrative processes and procedures associated with porting a telephone number could set the stage for slamming to increase exponentially. What concerns does the FCC have about slamming in the local loop and what actions are you taking to prevent it?*

Section 258 of the Telecommunications Act obligates the commission to ensure that no communication service is changed without the subscriber's authority. Our proposed rules implementing Section 258 are designed to carry out that mandate. We really want to slam the door on slamming.

We really want to slam the door on slamming.

Basically we've recognized that the potential is there for slamming of customers not just for interstate long distance but intrastate long distance, where there already have been a number of complaints, and also moving back to local competiton as it takes hold. Our rules, when we finalize them in an order [at press time they were part of a notice of proposed rule making], will address the local situation and the other situations I just described. We are fully prepared to take enforcement actions to make sure that consumers are not harmed in this process.

Will local exchange carriers be allowed or encouraged to validate porting requests with their customers?

There is great incentive on the part of the local exchange carriers to retain their customers. We want to make sure that we put in place procedures to ensure the customer is not slammed; however, we don't want to be so restrictive as to allow anticompetitive procedures to be introduced by the local exchange carriers in the guise of preventing slamming. So we are trying to balance those two objectives, again, always with the consumer first and foremost in mind.

Susan Ness, Federal Communications Commissioner

I heard that your secretary was slammed?

Yes, she was slammed by a long distance provider. There was a discussion several weeks ago on the topic of slamming at the Aspen Institute where I was attending a telecom conference. A number of other folks mentioned that they had been slammed. At the same hearing where I spoke, [Senator Conrad Burns (R-Mont.)] allowed as how a whole host of other folks, including his own family, had been slammed.

So, it is an extremely important issue. We don't have exact statistics on the number of cases of slamming. I can tell you that the number of complaints made to the FCC is on the rise. We had 16,000 complaints in 1996, and we already have 12,000 for the first six months of this year, and that is out of a total of 50,000 complaints to date.

Do you expect the rollout of LNP to increase the incidence of slamming?

Additional competition could add to inadvertent slamming, which could happen if someone keys in a wrong piece of information. With all the new ways of obtaining new customers, you have the potential for slamming. Once new entrants' switches are in place or they are reselling local service, you have the potential for telemarketers who are paid on a piece basis to slam a customer. [There are many scenarios] that can result in an environment conducive to slamming.

When do you think you'll have those slamming rules wrapped up and issued?

We are expecting to go to final order sometime this fall. ■

The Final Conquest: Universal portability

By early next year, service providers and equipment suppliers should have a pretty good idea of whether their efforts to provide a permanent solution to portability have succeeded—technically, that is. They may have to wait a few more months to find out whether LNP stimulates competition.

By next August, industry players and watchers will have the first inkling of whether or not business users and consumers really were eager to put all of their eggs in one basket and buy their local and long distance service from one provider. By next September, we should be able to tell if users actually were itching to switch back and forth from provider to provider to gather free minutes of use and cash awards—just like those they've been receiving for switching long distance providers.

By this time next year, we hopefully won't discover that users are so confused and fed up with the increased amount of telemarketing calls they get at dinnertime that they sneer at their phones every time they ring.

"People seem receptive to change, but it's difficult to prove what that number actually will be absent any demonstrable examples of where companies have gone in and marketed their services and monkeyed around with pricing," says Boyd Peterson, director of consumer communications for The Yankee Group. "Although two-thirds of consumers responding to a consumer survey said they would like to deal with one company, all of these things are imagined in the absence of real marketing."

Only time will tell.

Into the pool

LNP is sorely needed, whether or not customers take advantage of the network's astounding new capabilities, for the mere fact that the North American Numbering Plan is running out of 10-digit telephone numbers at an alarming rate, according to Herb Manger, business manager of telecommunications reform program management for Bellcore.

LNP's true claim to fame may be that it makes number pooling possible. Its introduction will be even more critical if service provider portability is a success, because under the current numbering plan new local service providers must be assigned blocks of NXXs (exchange codes) for the purpose of routing and rating calls.

"Number pooling would instead allow those NXXs to be shared among local carriers, so we won't have to exhaust and expand the number of NPAs (area codes)," he adds.

Illinois aims to implement number pooling in early 1998 to relieve the exhaust of numbers in the 847 area code northwest of Chicago, according to Manger. Pennsylvania has ordered number pooling to take place when LNP is rolled out in Pittsburgh next year.

"If we can get number pooling to work correctly, it will push out the exhaust of existing numbering plans. We are studying how long it will push the date out now," he says.

What do you do for an encore?

The second type of portability carriers hope to provide is location portability. Existing networks and equipment will have to be updated so users can take their numbers out of their existing rate centers. The way carriers currently bill for their services will be impacted greatly when customers start moving out of their rate centers.

Today, all billing systems are driven by NPA-NXX relationships and all billing systems are geared to determine the distances between the originating point and termination point of a call, according to Manger.

"As soon as you move telephone numbers outside of their traditional NXX areas, you break that billing paradigm," he adds. "You'll have to have industry agreement on what billing information you want to collect and how you will recognize billing areas."

Although the billing paradigm will have to change, it's likely that billing still will be tied to something physical in the network. Even if carriers were to use postalized rates, there would have to be some way to tell equipment involved in processing a call that the call was going from point A to point B, Manger says.

"Ultimately, in 10 to 15 years, we'll have universal portability, and you'll be able to take your number from the U.S. and move to Europe with it," predicts Ernie St. Germaine, vice president of telecom business development for Perot Systems. "Of course, by that time we'll probably have a 15-digit numbering plan." ■

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generations of digital loop carrier systems, may be more [cost-effective] for telcos as opposed to a deep fiber SDV solution."

For those already committed to the HFC route, Pishall argues that "packet video of broadcast quality is happening today over good cable systems." In the LEC world, he says, "the battlefield isn't about who is going to offer video and how, it's about high-speed data to the home. Whether that's ADSL for the telcos and cable modems for [multiple systems operators], they have a number of priorities; one is offering an enhanced video opportunity."

Bell Atlantic, the RBOC best known for "stirring the pot," according to SNET's Denenberg, seems undaunted in its commitment to FTTC/SDV solutions. The company is making major investments in network infrastructure, in ISDN buildouts, in ADSL (especially for telecommuting, on-line services, and Internet access—commercially available next year) trials and now, an FTTC/SDV installation in the consumer residential market. The "laboratory" is Ocean County, along the Jersey shore.

"We've employed FTTC architecture for both telephony and broadband cus-

was designed to link 12 to 18 homes from a single node."

Future upgrades will connect up to 32 homes per node. Rider says Bell Atlantic will see a deep fiber solution through—for modernizing its network and delivering residential entertainment and interactive services (including video-on-demand and pay-per-views, plus a full suite of data services).

"We're competing with cable TV and satellite broadcasters as well as driving down the cost of our business," Rider says. "Cost avoidance is a significant factor with FTTC; with fiber, and moving into digital transport, you have lower chances of failure and better diagnostic tools to solve a problem."

Whereas ADSL is already being deployed successfully in 1,000 homes in northern Virginia (one application is video-on-demand), Rider says that the copper solution is only interim. "We've used it successfully for high-speed data access and will launch in mid 1998 as a service," he says. "But you can't have an all-copper network. xDSL will meet many of the bandwidth requirements in the next three to five years, but it won't provide 52 megabits to end users in an efficient manner." For that, deeper fiber

driving these two technologies closer to each other. We may see a blend... because both are trying to drive fiber deeper and deeper."

As for ISDN, it may be a more effective solution than carriers—and customers—have realized. "ISDN doesn't look so bad when compared with ADSL; in fact, we've got 100% ISDN accessibility in my state right now," Denenberg says. "We may need to figure out ways to price ISDN so that it's not by the minute; customers buying cable modems at $50 a month might actually consider ISDN [as an alternative]. Because cable modems can groom a lot of traffic off my switching fabric, that drives me to consider services like IDSL, which has the characteristics of ISDN but does not clog up the switching fabric."

Whatever the choices, the underlying issues of which technology/which transport are less important than the solutions the customer wants.

"Everyone has to look inward to their marketplace, figure out what their customers want, and whether they can make a buck at it," Denenberg observes. "This is not the generation of technology pull. It's a customer-focused game." ■

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continued from page 30

says. Bell Atlantic would dispute that—the RBOC already has a fully deployed FTTC network for broadband data, SDV and telephony in Dover Township, N.J. It's part of an aggressive plan to squeeze maintenance costs out of the existing network while providing an array of residential broadband services. But Pishal's point is well taken: SDV for a residential broadband market has yet to prove itself as a price-wise contender.

"With SDV, you have to put a digital set-top box on top of TVs with a digital signal, and no one has done this for less than $300," he says. An analog box, by contrast, costs "around $180 depending on features. In addition, SDV requires new infrastructure... [whereas] other technologies such as ADSL over existing copper, or the new generations of digital loop carrier systems, may be more [cost-effective] for telcos as opposed to a deep fiber SDV solution."

For those already committed to the HFC route, Pishall argues that "packet video of broadcast quality is happening today over good cable systems." In the LEC world, he says, "the battlefield isn't about who is going to offer video and how, it's about high-speed data to the home. Whether that's ADSL for the telcos and cable modems for [multiple systems operators], they have a number of priorities; one is offering an enhanced video opportunity."

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"We've employed FTTC architecture for both telephony and broadband customers; it's an integrated platform," says Bob Rider, director of broadband planning and development at Bell Atlantic Network Services. "We use ATM for broadband services, and we're transmitting and delivering MPEG2 [Motion Picture Experts Group 2; a digital video format standard], digitally encoded, ATM formatted, video signals to the home. The one video provider is Bell Atlantic Video Services, and the system was designed to link 12 to 18 homes from a single node."

Future upgrades will connect up to 32 homes per node. Rider says Bell Atlantic will see a deep fiber solution through—for modernizing its network and delivering residential entertainment and interactive services (including video-on-demand and pay-per-views, plus a full suite of data services).

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"Technology is a movable feast. As HFC continues to evolve, as SDV continues to evolve, many of the developments...are driving these two technologies closer to each other. We may see a blend...because both are trying to drive fiber deeper and deeper."
—Charlotte Denenberg, SNET.

SNET's Denenberg says some form of hybrid SDV and HFC may be the wave of the future. "Technology is a movable feast," she says. "As HFC continues to evolve, as SDV continues to evolve, many of the developments which are happening as we speak are driving these two technologies closer to each other. We may see a blend... because both are trying to drive fiber deeper and deeper."

As for ISDN, it may be a more effective solution than carriers—and customers—have realized. "ISDN doesn't look so bad when compared with ADSL; in fact, we've got 100% ISDN accessibility in my state right now," Denenberg says. "We may need to figure out ways to price ISDN so that it's not by the minute; customers buying cable modems at $50 a month might actually consider ISDN [as an alternative]. Because cable modems can groom a lot of traffic off my switching fabric, that drives me to consider services like IDSL, which has the characteristics of ISDN but does not clog up the switching fabric."

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Making HDSL2 fly right

As interest over the next-generation of HDSL grows, how the technology will be modulated becomes critical. CAP just might be the solution.

THE BUZZ SURROUNDING SINGLE-PAIR HIGH-SPEED DIGITAL SUBSCRIBER LINES (HDSL), WIDELY KNOWN AS HDSL2, HAS BEEN STEADILY GROWING SINCE THE COPPER TECHNOLOGY WAS FIRST PROPOSED. BUT BEFORE HDSL2 DEVELOPS BEYOND THE IDEA STAGE, AND INTO ACTUAL DEPLOYMENT, VENDORS AND CARRIERS ALIKE MUST NAIL DOWN EXACTLY HOW HDSL2 IS TO BE MODULATED BEFORE IT CAN BE STANDARDIZED.

Enter Carrierless Amplitude Modulation (CAP). CAP is under active consideration for new proposed versions of HDSL. The wide success of this modulation scheme in current HDSL and Asymmetric Digital Subscriber Line (ADSL) systems, its flexibility, and its potential performance advantages, has led to a strong interest in its use for future versions of HDSL now under study.

FIRST-GENERATION HDSL

First-generation HDSL systems have been in service for a few years. HDSL deployment is fairly substantial in many regions of the world, largely for provisioning of T1 and E1 services to customers, and for digital connection of cellular and PCS base stations to the public telephone network. In North America, they have been used mainly to provide T1 bit rate (1.54 Mbps), full duplex communications between customers' premises and telephone company central offices using the regular subscriber loop plant. Two pairs are used, each carrying half the payload full duplex, in an arrangement known as "dual duplex." The range covered without repeaters corresponds to that defined as a "carrier serving area" (CSA), which is up to 12,000 feet of 24 gauge wire or 9,000 feet of 26 gauge, with limitations on bridged taps and gauge changes. The range is determined such that satisfactory communication is achieved with 6 dB margin against near-end crosstalk from up to 49 similar systems in the same cable. In Europe, E1 rates (2.048 Mbps) are carried over either two or three pairs, again without repeaters, over a range comparable to a CSA.

Two modulation methods for current HDSL have been specified in technical reports issued by American and European standards bodies. The modulation method mostly used in the United States is four-level Pulse Amplitude Modulation (PAM), baseband, commonly referred to as "2B1Q" because it maps two bits into one quaternary symbol. This modulation format was adopted largely because of its previous use for basic rate ISDN access, and the perception, valid in the past, that a baseband PAM system should somehow be simpler to implement than a modulated passband format. On the other hand, CAP is widely used in Europe, South America and Central America for two-pair E1 HDSL, which has been found to provide comparable performance to three-pair E1 HDSL systems using 2B1Q.

NEXT-GENERATION HDSL

The new variations of HDSL, proposed under such names as SDSL, SHDSL and HDSL2, cover a wide range of bit rates and distance ranges, but all seem to involve the use of only a single pair, unlike current HDSL. As in current HDSL, the services proposed are full duplex symmetric, providing the same bit rate in both directions. The most immediate proposal is to use existing HDSL technology, with very little modification, to provide 1168 kbps over a CSA, or lower rates, down to 384 kbps, over the full, unloaded subscriber plant (up to 18 000 feet). Further into the future, it is anticipated that more advanced techniques will be employed to achieve higher rates over a variety of distances. A particular challenge is to achieve T1 and even possibly E1 rates over a CSA on a single pair. Another future possibility is the provisioning of a

standard analog voice channel on the same pair as HDSL.

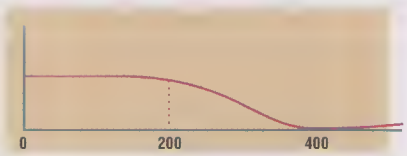
There are therefore two distinct comparisons to be made. First, passband alternatives to existing 2B1Q technology are considered for the more immediate applications. For the longer term, passband technology must be compared with more optimized baseband schemes.

In addition to baseband PAM schemes, there are two passband contenders for future HDSL systems. In ADSL, both CAP and Discrete Multitone (DMT) modulations are being used to provide required passband transmission. The relative merits of these two modulation formats have been extensively discussed elsewhere, especially in the ADSL arena, so this article will concentrate only on CAP as an alternative to baseband PAM. However, while DMT cannot be discarded as a possibility for a future generation of HDSL systems, the high latency (delay) inherent in DMT precludes its use in many HDSL applications.

CURRENT 2B1Q MODULATION FOR HDSL

In current 2B1Q implementations of HDSL, pairs of bits are assembled in a serial-to-parallel converter in order to form four-level symbols at a rate equal to half the bit rate. These symbols are directly coupled to the line, typically with no digital filtering in the transmitter and with rather gentle analog filtering, such as a fourth order Butterworth. The spectrum on the line is illustrated in Figure 1.

Figure 1



Spectrum of current 2B1Q system. 400 sym/s.

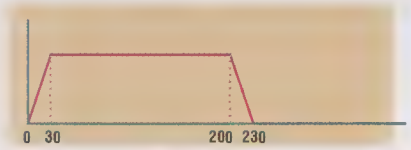
The baseband signal presented to the line is always transformer-coupled for several reasons, including provision of a hybrid for two-directional transmission, elimination of d.c. levels in the line driver, and provision of balancing. Decision feedback equalization (DFE) in the receiver, among other functions, provides the d.c. restoration, which is essential to correct for the effects of transformer coupling. The DFE typically uses only a rudimentary forward section, such as a fixed form, which leads to suboptimum performance.

BRIEF DESCRIPTION OF CAP

CAP can be considered to be a variation of Quadrature Amplitude Modulation (QAM), to which it is fully equivalent in performance. However, unlike QAM, no explicit modulation and demodulation is used. Instead of modulating a pair of carriers in quadrature, CAP passes pairs of symbols through a "Hilbert pair" of bandpass filters, that is, two filters with the same amplitude response and phase responses that differ by 90 degrees over the frequency band. It is therefore the equivalent of two passband PAM systems superimposed on each other.

Figure 2

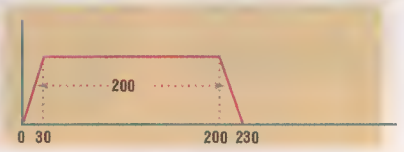
Spectrum of an optimized PAM system. 400 sym/s., 15% rolloff.



Spectrum of a CAP system. 200 sym/s., 15% rolloff.

Figure 2 is a simplified block diagram of a CAP system. At the transmitter, input data are blocked and mapped into symbols which are split into two streams. A pair of symbols, one from each stream, may be described as a two-dimensional, or a complex, symbol. These symbols are fed through the Hilbert pair of filters, added and coupled to the line. The line spectrum is typically tightly controlled, largely by the digital Hilbert filter pair. Figure 3 shows a CAP signal placed such that the

Figure 3



Spectrum of 16 point CAP system. 200 sym/s. 15% rolloff.

lowest frequency component is at zero frequency.

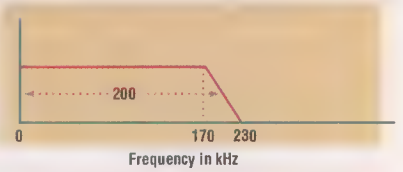
At the receiver, the symbol streams are separated by another Hilbert pair of filters. These filters are actually synthesized by an equalizer, which eliminates both intersymbol interference and interference between the two streams. A DFE with a fairly long adaptive forward section is invariably used in order to provide good performance over the subscriber line, which has high variability of loss with frequency, and in general highly non-white noise due to crosstalk from other pairs in the cable. It should be noted however, that the DFE is not absolutely required as it is in baseband systems.

GENERAL COMPARISON

Before examining performance issues associated with current 2B1Q, generalized ideal baseband and passband systems must first be compared. Best performance of the passband system is achieved when its low-end rolloff extends down to zero frequency. Equivalent PAM and CAP systems occupy the same bandwidth. This is illustrated by comparing Figure 4, the spectrum of an idealized system with 15% rolloff that carries 800 kbps using four-level PAM, with Figure 3, a 16-point CAP signal that carries the same bit rate with the same rolloff.

These systems are equivalent because the CAP symbol is two-dimen-

Figure 4



Spectrum of an optimized 4-level PAM system. 400 sym/s. 15% rolloff.

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sional, carrying twice the number of bits per symbol but at half the number of symbols compared with the PAM signal. The equivalence extends to performance in Gaussian noise. Each of the quadrature channels in CAP uses half the power of the PAM signal, producing the same total power. The noise power in each CAP channel is also half that in the PAM system, therefore yielding the same signal-to-noise ratio, and thus the same error probability.

Performance of subscriber line systems is typically compared using an agreed-on set of test lines, which may for example constitute extreme cases of CSA channels. In addition, extreme cases of crosstalk are used as the noise source. One common noise source is "Self-NEXT," which is near-end crosstalk from identical signals in the same cable. This form of crosstalk is particularly severe because of the full spectral overlap. Although Self-NEXT may not be the dominant noise source in many actual conditions, it is the most widely used in specifications, assuming up to 49 interferers, and in laboratory testing.

Additional test noises are other wideband services which may share the cable, such as T1, ADSL and Itegrated Services Digital Network (ISDN). In these cases, we must consider both the effects of those systems on the one in question, as well as the interference of the proposed HDSL system into the other services. Several extensive simulations have been performed by many organizations, and for comparable passband and baseband systems, the tests usually show performance within a fraction of a dB for all such tests.

PERFORMANCE COMPARISON WITH CURRENT 2B1Q

All current implementations of 2B1Q for HDSL use simple, low-cost devices, in particular transmit filtering that produces the spectrum shown in Figure 1. The excess high frequency energy can lead to spectrum compatibility problems, such as crosstalk into current HDSL, ADSL and T1 systems in the same cable. Current CAP implementations, on the other hand, use digital filtering as well as analog in the transmitter, so the transmitted signal is much closer to the ideal of Figure 3. In particular, the signal remains more than 35 dB down beyond the 15% rolloff region.

Other limitations of 2BIQ include its rigid four-level alphabet size. In many cases,a larger alphabet can produce better performance.

Other limitations of 2B1Q include its rigid four-level alphabet size. In many cases, a larger alphabet can produce better performance in noise. It will always use less spectrum for a given bit rate. Furthermore, 2B1Q never includes trellis coding. Trellis coding provides approximately 4 dB performance improvement in noise. Because of all these limitations of 2B1Q, whereas a trellis coded 64-point CAP system can communicate at 1,600 kbps with 6 dB margin in high self-NEXT over a single 10,500-foot pair of 24 Gauge cable, 2B1Q is restricted to 9,000 feet under the same conditions. Moreover, the susceptibility to crosstalk from other signals can be even worse. Of even more concern, the crosstalk of a 2B1Q signal into an ADSL signal can have an 8 dB worse effect on the ADSL signal than the CAP system. Introduction of a new signal format that can severely degrade an existing service is always a matter of great concern.

COMPARISON BETWEEN CAP AND AN IMPROVED PAM SIGNAL FORMAT

The limitations of 2B1Q are well understood, and more advanced baseband PAM techniques have been proposed for future high-performance HDSL systems. For higher rates, a larger alphabet achieves better performance. Again, the larger alphabet also reduces the bandwidth used, and so achieves better spectral compatibility with other services. Addition of digital filtering in the transmitter, and sharper analog filtering such as eighth order Butterworth, also reduces the spectral compatibility problem.

Trellis coding can also be added to the PAM format. One-dimensional coding is most natural, but better coding gain is achieved with two or higher dimensional coding. This requires grouping of symbols to be treated as super-symbols for coding. When a PAM system is optimized in these ways, its theoretical performance in noise is very close to that of a CAP system. In particular, a trellis coded 16-PAM system has just about the same distance reach as a coded 64-CAP system in Self-NEXT and other crosstalk. The potential for interference into other systems is also comparably low.

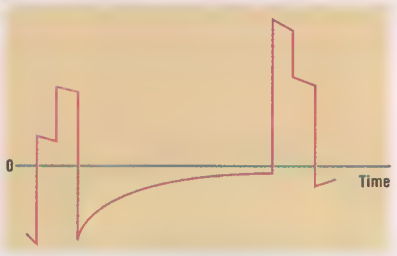
OPTIMIZED BASEBAND AND PASSBAND COMMUNICATIONS

As previously discussed, optimized baseband and passband systems will perform very similarly if both are ideally implemented. However, there are inherent implementation concerns, associated with low-frequency effects, which favor the use of passband modulation.

The first problem associated with baseband transmission through a channel with a null at zero frequency, due to transformer coupling, is usually referred to as "d.c. wander." After a long sequence of all-positive or all-negative symbols, the transformer output will settle to a value close to zero. When a symbol of the opposite polarity arrives, a peak of up to twice the nominal signal amplitude will occur. This effect is illustrated in Figure 5.

This means that the line driver, D/A and A/D converters, and amplifiers must provide 6 dB added headroom to avoid clipping. For the D/A and A/D converters, this requires one additional bit. In addition to the higher cost, this requirement also leads to increased power drain, which is frequently a major

Figure 5



A baseband PAM signal, transformer coupled, illustrating d.c. wander.

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issue in subscriber line systems. A passband system on the other hand, does not have a d.c. wander problem. It requires 3 dB added headroom because of the peak of a sine wave compared to d.c of the same power. The net difference in peak-to-average power ratio between baseband and passband signals, a key measure of the need for added headroom, is therefore 3 dB.

Another effect of transformer coupling on baseband transmission is the long tail in the system impulse response. To equalize it out, and even more so to cancel echo, requires an equalizer and echo canceller with very many taps. To the extent that the tail can be approximated by an exponential time function, tail cancellation techniques can, and are, used to reduce the required length of the equalizer and echo canceller. However the number of taps needed is still substantially larger than in a passband system.

An additional low-frequency problem is that of delay distortion. This problem exists in the transmission line itself, and would be present even without transformer coupling. At low frequency, the envelope delay variation is very large, becoming flat at around 10 kHz. The transformer adds additional delay distortion. While delay distortion does not effect performance if properly corrected, it again increases the number of taps needed in the equalizer and echo canceller of a baseband system.

Another low-frequency effect inherent to the transmission line itself is the rapid increase in its characteristic impedance, which goes to infinity at zero frequency. Among other effects, this makes balancing of hybrids extremely difficult in baseband systems, and therefore increases the requirements of echo cancellation.

ADDITIONAL SYSTEM CONSIDERATIONS

Neither the present HDSL nor any of the proposed next versions (HDSL2, etc.) provide an analog voice channel. Later versions may include this, as does ADSL. Providing this additional channel requires that the data channels be passband. Because a conventional voice channel contains some very large signals such as ringing and battery interruption, it was found in ADSL that the data channels could not begin until 30 kHz or 35 kHz, even though the voice channel ends below 4 kHz. The performance penalty for moving the spectrum up by this amount is significant. Crosstalk to and from other services is also substantially increased. For home and small office applications, provision of a voice channel on the same pair may be sufficiently desirable to justify these penalties. It should be noted that a well-designed CAP system that is offset by 30 kHz still outperforms current 2B1Q implementations.

A passband modulation scheme, CAP in particular, can provide both the added performance and flexibility that would be highly desirable.

If it is known that the predominant impairment will be crosstalk from identical systems in the same cable, then it may be advantageous to separate the two directions of transmission by frequency division rather than echo cancellation. This of course again requires passband transmission. Near-end crosstalk among the new HDSL systems in the cable is eliminated, at the expense of greatly increasing the required bandwidth. Crosstalk to and from other services is increased.

BURTON R. SALTZBERG, ScD, is a consultant in digital communications. He was with Bell Laboratories from 1957 to 1996. His most recent position there, which he held for several years, was technical manager of the Data Theory group. He has published extensively in this field, and was issued 27 U. S. patents. He has held several offices in the IEEE Communications Society. Dr. Saltzberg was elected a Fellow of the IEEE in 1976 for contributions to data communications. He received the IEEE Communications Society Armstrong Achievement Award in 1991.

Crosstalk from T1 or E1 signals into the upper HDSL band may be especially severe. Use of larger constellations, and therefore lower symbol rates, partially reduces the spectrum.

CONCLUSIONS

Extending current 2B1Q technology to new single pair HDSL services will cause significant performance and spectral compatibility problems. The substantial excess bandwidth would degrade the performance of ADSL and other wideband services in the same cable. Also, there is little flexibility in providing a wider variety of new services.

A passband modulation scheme, CAP in particular, can provide both the added performance and flexibility that would be highly desirable. The use of a higher constellation size and sharper transmitter filtering lead to a more compact spectrum, and therefore substantially better spectral compatibility with other services. Trellis coding can greatly improve performance, extend the reach by approximately 1,500 feet in self-NEXT.

Certainly these same benefits could be achieved by using an optimized baseband PAM scheme rather than today's 2B1Q. However, implementation issues suggest that CAP is a better choice. Transformer coupling of a baseband signal produces d.c. wander and a long impulse response. The transmission line itself introduces high delay distortion and a highly variable characteristic impedance at low frequencies. Solving these problems requires more dynamic range (headroom) in analog components, and a longer equalizer and echo canceller, than would be required in a CAP implementation.

It should further be pointed out that CAP technology has matured considerably since HDSL was first proposed several years ago. Low cost, high performance components used in ADSL could readily be adapted to these new HDSL applications. With CAP's wide use in current ADSL and HDSL, its flexibility and better performance, developers of HDSL2 solutions and networks services should give this modulation scheme careful consideration. ■

BROADBAND Notebook

DEBBIE L. SKLAR

ATM MARKET ABOUT TO BOOM

The market for asynchronous transfer mode (ATM) and frame relay products will more than double by the turn of the millennium. According to *Scaling the Web: Primetime for ATM?*, a report by **Datamonitor's Web Technology Research Program**, the total worldwide market for ATM switches and frame relay switches will grow from $1.4 billion in 1996 to $5.2 billion in 2001. Also forecasted, the increasingly-important access space—the market for remote access servers and concentrators—may reach $7.2 billion by 2001.

Datamonitor forecasts that the worldwide frame relay market will grow from 1996's $910 million to $2.3 billion in 2001. Growth rates for ATM switching in the WAN will be even more impressive, with total revenues rising from $530 million in 1996 to $2.9 billion in 2001.

The key driver in both markets will be the efforts of Internet service providers (ISPs) and other carriers to provide the 'plumbing' for fast, flexible, secure, multiapplication Internetworks. In fact, "scaling the Web" in the wide area will demand a combination of technological solutions. There will continue to be room in the growing WAN market for ATM, frame relay and high-end routers, not to mention Sonet and Synchronous Digital Hierarchy (SDH).

Further, the report says the worldwide access concentrator and server market will grow to $7.2 billion by 2001. This forecast underlines the fact that access technologies, as well as WAN backbone equipment, are set for growth in the Web-led wide area.

Access equipment is playing a key role at corporate sites and service provider points of presence (POPs). High-capacity devices such as remote access concentrators, rather than more established technologies such as multiplexers and CSU/DSUs, will be increasingly deployed to manage the pressures of burgeoning traffic flows, multiple wide area links and ever-diversifying traffic types. The access concentrator market alone will rise from $1.1 billion in 1996 to $5 million in 2001, with ISPs accounting for 51% of this total.

JONE'S COMMUNICATIONS UNVEILS HFC NETWORK IN VIRGINIA

Cruising the Internet in portions of Prince William County, Va., is about to get easier.

Jones Communications' cable television customers will be using cable modems and the **Jones Internet Channel** to make cruising the World Wide Web effortless. Joined with a Hybrid Series 2000 cable modem, Jones Communications' hybrid fiber-coax (HFC) network will offer a high-speed information pipeline to customers, allowing them to receive data up to 200 times faster than traditional means.

"Cable technology offers an unsurpassed ability to deliver interactive products and services such as data and high-speed Internet access to the world's homes and offices," says Glenn R. Jones, chairman and CEO of Jones International Ltd., the parent company of Jones Internet Channel and Jones Communications.

Using a home computer, Jones Internet Channel customers will be able to download up to several Mbps via Hybrid Series 2000 cable modems, as opposed to traditonal analog modems' download speeds of 28.8 kbps to 53/56 kbps.

Gary Lyons, an Eastern Prince William County customer who volunteered to be a participant on Jones' beta test of the high-speed service and who has ordered a fully loaded, top-of-the-line computer in anticipation of Jones Internet Channel says, "The speed is blazing. I love [the service]. It's like a cloudburst in a thunderstorm. It pours."

Jones Intercable is among the nation's 10 largest multisystem cable television operating companies, serving about 1.5 million customers in 17 states.

GTE MEDIA VENTURES LAUNCHES DIGITAL SERVICE

GTE Media Ventures has become the first local carrier in the country to offer digital service via an upgrade to its video services network in Florida, increasing its **americast** programming from 70 to 114 channels.

In addition to greater programming options, the digital enhancement delivers improved picture quality and **Music Choice**—more than 30 channels of CD-quality commercial-free music. It also includes **StarSight**, an on-screen television program guide with one-button VCR recording.

GTE's hybrid fiber-coaxial network currently passes 150,000 homes in several Florida cities. If GTE can keep up its deployment pace, it might reach 400,000 homes by the end of 1998.

GTE designed its video networks in Florida and Ventura County, Calif., to accommodate digital service from the outset. "We are building our network…to provide superquality, two-way broadband transmission that will be the foundation for a host of services to come over the next decade," says Rick Wilson, president of GTE Media Ventures.

GTE's Ventura County video network will "go digital" later this fall.

MCI MAKES READY FOR OC-192 AND WDM DEPLOYMENT

MCI is moving ahead with its deployment of a 40 Gbps single-fiber link using OC-192 and wave division multiplexing (WDM) on its original route between Chicago, Ill., and St. Louis, Mo. Marking a major step forward in that deployment was a recent purchase of **Hitachi Telecom's** AMN 5192 OC-192 Sonet transmission equipment.

"The combination of OC-192 with WDM is an important part of MCI's 'network of the future,' and the performance of the systems on the Chicago-to-St. Louis route have met our expectations, proving the viability of this technology," says Jack Walters, MCI's vice president of engineering.

The AMN 5192 Advanced Multiservice Node supports applications ranging from long-haul transmission to metropolitan rings. It supports growth beyond 10 Gbps to 160 Gbps through WDM, which lets carriers to divide and condense fiber optic transmissions into separate wavelengths to increase fiber infrastructure capacity and flexibility.

In June, Hitachi announced the phased availability of close-tolerance lasers meeting the **International Telecommunication Union (ITU) Grid** specification.

ARIELLE EMMETT

PCS '97: fabulous, silly, grand

Featuring outstanding products, alliances, tough talk against federal regulators and a growing realization that subscribers come first.

DALLAS, (SEPT 10, 1997) GOV. GEORGE W. BUSH WAS ON STAGE BY VIDEO PROXY AND THE MAYOR OF DALLAS SAYS THE CITY'S FAVORITE CONTACT SPORT IS SHOPPING. NEARLY EVERY PERSONAL COMMUNICATIONS SERVICES (PCS) SHOWCASE EXPERT INTERVIEWED BY PCIA PRESIDENT JAY KITCHEN COMPLIMENTED HIS COWBOY BOOTS. WAS THIS IMPORTANT AND TRENDSETTING?

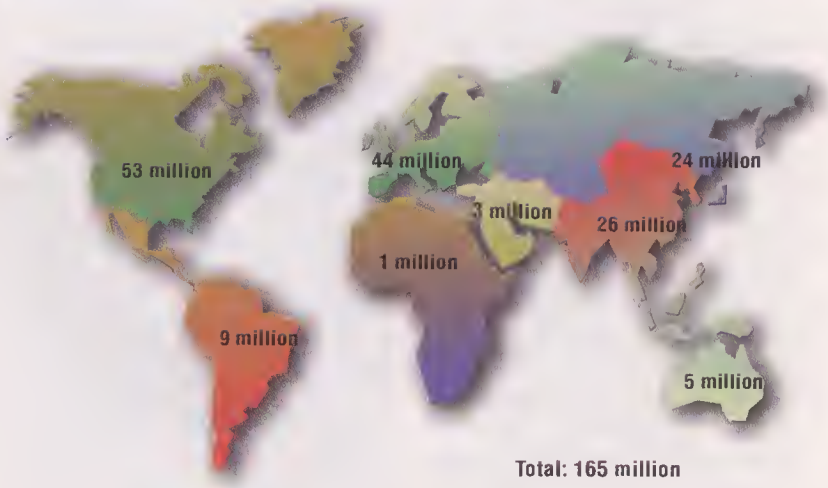
The opening SuperSession of PCS '97, now the largest wireless trade show on earth, unfolded like a "Good Morning America" newscast before TV cameras; huge video screens and thousands of attendees.

The mood was happy, similar to an hour-and-a-half-long infomercial, complete with "Maw and Paw Kettle" characters extolling the virtues of PCS on video tape—plus a number of real video commercials (sponsored by Nortel, Philips and Qualcomm) were piped into SuperSession video screens between segments of the opening newscast. One particular commercial featured a husband stranded on an oil rig, talking for six hours to his wife on a Philips PCS phone while she bravely gave birth thousands of miles away.

PCIA president Jay Kitchen hosted the SuperSession with lots of walk-on interviews. The liveliest: a discussion on global PCS with Larry Irving, assistant secretary of Commerce who will host a pan-Asian PCS forum in China this fall. Irving says he has his own personal PCS phone, but the government had only given him a cellular one. "The government's a little bit behind," he says.

Video interviews with concerned industry leaders, such as Andrew Sukawaty of Sprint PCS and Sen. Ernest Hollings, D-S.C., the chairman of the House Telecommunications Subcom-

World's cellular subscribers (in millions by region as of June 1997).



Total: 165 million

Source: Ericsson

mittee, outlined the problem of federal spectrum mismanagement. The message: spectrum is a scarce resource, not a government cash cow, so get over it. The opening session featured a stage manager (actually a 'warm up' actress) in need of a makeover and an anchorman who resembled a Ken doll in his delivery style, but perhaps not as smooth. In all, a bow to silliness, glitz and short attention spans—a trademark of the '90s.

Was there any substance to PCS? Yes, of course. Featured at a kick-off garden party were the Leningrad Cowboys, a group of "Russian" rock pompadour queens, hosted by wireless trendsetter Nokia. The band played in a hot, bright evening to thousands of PCS attendees at the Wyndham Anatole hotel, headlined by a performer who resembled Wilma Flintstone (dressed in combat boots, with 3-foot-high hair). The music blared in a fashion representative of the entire wireless industry; a weird hybrid of the Dallas Cowboys' fight song and the "Volga Boatmen" in drag.

Showmanship, of course, was the outer trappings. At PCS '97, the real news was that PCS is actually up and running despite the C block bankruptcies; 41% of all U.S. households now have a wireless device (pagers, PCS, cellular phones, included), 9% now plan to purchase a wireless service within the next six months, and PCIA is projecting more than 200 million Americans will go wireless by 2001, and 600 million people globally.

The message? There is a transition in industry emphasis over last year: wireless infrastructure buildouts and arguments about air interface compatibility and capacity aren't as important as customer retention and making money on new services. Today, call management, wireless data, fixed and mobile convergence, integrated single number service, customer care, billing, fraud busting, C block bail outs, and the need for long-term wireless spectrum policy, eliminating outdated regulation—all these themes struck home at PCS '97 again and again. The show featured many outstanding products and services, intriguing alliances and trends.

Was there any substance to PCS? Of course. Featured at a kick-off garden party were the Leningrad Cowboys, a "Russian" rock band.

Here are some highlights of the big event:

NORTEL WIRELESS NETWORKS

Nortel's Wireless Networks president Matthew Desch argued that the era of "fixed wireless and mobile convergence" is coming rapidly. At an early morning press conference, Desch pointed to numerous Nortel accomplishments in PCS—notably the development of the S8000 Base Transceiver Station (BTS), a Global System for Mobile (GSM) signal processing unit offering the industry's highest dynamic receiver sensitivity—110 dBM. This achievement, Desch says, has rocketed Nortel to the top of the list in GSM 1900 digital wireless infrastructure bids. The company is pushing for U.S. spectrum allocation to integrate wireless and wireline services and switching. "We want the Telecom Act to allocate spectrum (e.g., in the 3.34 GHz to 3.72 GHz range) to enable us to put wireline and wireless together... to give us a wireless equivalent that is absolutely identical to wireline access," he says. Nortel is fresh from a $300 million IS-136 (TDMA) infrastructure win in the Saõ Paulo metro region of Brazil in that country's recent "B band" auctions; the company is also pushing for fixed wireless CDMA services in Guatemala. Nortel is also a maker of next generation mobile phones, with the advent of new models, the 1920 and 1930, voice recognition will be available. "As a network infrastructure supplier, we are up 82% this year in wireless," Desch says. "We are the fastest growing infrastructure supplier out there." Seemingly from out of nowhere, Nortel appears to be taking market share from Motorola and other suppliers. The company's DMS-100 switch for wireless and wireline is an infrastructure winner.

PHILIPS

Philips Consumer Communications offers some of the most beautifully designed and lightweight Smart Phones at PCS '97. Great leaps ahead of the Nokia 9000 Communicator, the Philips PCS 1900 Digital Phone includes a "cradle" to the handset providing such features as the ability to send and receive faxes, e-mail and Internet access and short messaging service (SMS) on a touch-screen using either a stylus device (the unit also "recognizes" a user's handwriting and printing on its backlit 640-by-200 pixel screen display) or a "virtual keyboard" projected on the graphical interface. The data and mes-

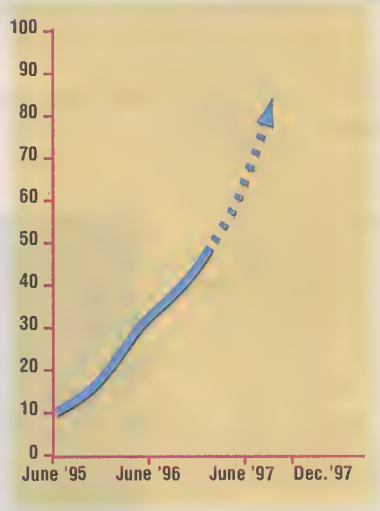
Digital cellular index
June 1997

GSM
In 109 countries/areas
Subscribers: 47 million

D-AMPS (IS-136)
In 34 countries
Subscribers: 5 million

PDC
In Japan
Subscribers: 20 million

IS-95
In 7 countries
Subscribers: 3 million



Source: Ericsson

saging phone companion provides full access to the World Wide Web through the stylus and a keypad-activated browser; icons are incredibly clear and readable. This seems to be the first handheld phone device that is actually large and readable enough to make full use of the 'Net, including downloading files.

LUCENT TECHNOLOGIES

Lucent Technologies, now partnering with Philips in a joint handset venture, premiered several 1.9 GHz PCS phones, including the new 6735, a dual mode, dual band unit developed by Bell Laboratories that uses both analog and TDMA cellular (800 MHz) as well as digital PCS 1.9 GHz. All new Lucent wireless terminals will be marked under the Philips brand after the joint venture between Lucent and Philips, called Philips Consumer Communications, is launched officially on Oct. 1.

The infrastructure news for Lucent, though, is its third party open services approach, known as "Cooperative Innovations," a way of helping wireless carriers develop new applications rapidly to grow service revenue and streamline network operations. Lucent stresses the development of formal alliances to accomplish these tasks. Partners include Corsair and CTS for RF fingerprinting and fraud detection (and a "kill call" function); Subscriber Computing Inc. for pre-paid services, Centigram Communications for four-digit abbreviated dialing and other enhanced services, and SignalSoft Corp.'s location based services for wireless E911 and other emergency services.

Scott Erickson, Lucent's vice president of AMPS/PCS Wireless Systems, says Lucent will ease the burden of network operators by acting in many instances as a sys-

The infrastructure news for Lucent, is its third party open services approach, known as "Cooperative Innovations."

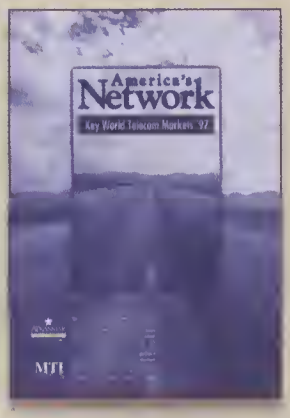
tems integrator, responding to unique market needs. Single number service is likely to become an important application for wireless subscribers going forward. "For certain individuals, it's a great idea," he says. "Especially those with four or five phone, fax and mobile numbers." Erickson suggests that from a design and signalling standpoint, implementation of single number service may actually be less complex than separately engineering wireless access for POTS, fixed wireless and other services. Because of the scope and switching capabilities within the Lucent network, "we may be able to keep [single number switching] all within the network, making the deployment easier than separate gateways.

All Lucent's "Cooperative Innovations" third party applications will be written under a suite of standard industry protocols and interfaces, he adds. Erickson says Lucent is now the number one wireless infrastructure supplier in the U.S. in terms of cellular and PCS equipment based on North American standards, notably analog, CDMA and TDMA. The company commands 60% of the U.S. CDMA infrastructure market and has 5,000 to 6,000 base stations in commercial service. "We've been proving to customers that the design and implementation of our equipment is based on evolvable platforms that deliver the best life cycle [cost] benefits to service operators," he contends. In short, "I don't throw anything out," he says, even as wireless networks evolve from analog to digital to third generation wideband.

Erickson says several major infrastructure competitors have had to ditch earlier designs of base stations and other equipment in order to satisfy new

Philips showcased its line of lightweight smart phones and other devices at PCS '97. One of its newest phones is a PCS 1900 device (above, far left) that includes a "cradle" to the handset that provides such features as the ability to send and receive faxes, e-mail and Internet access and short messaging service (SMS) on a touch-screen using either a stylus device or a "virtual keyboard" projected on the graphical interface.

Staying on Top Requires Superior Intelligence



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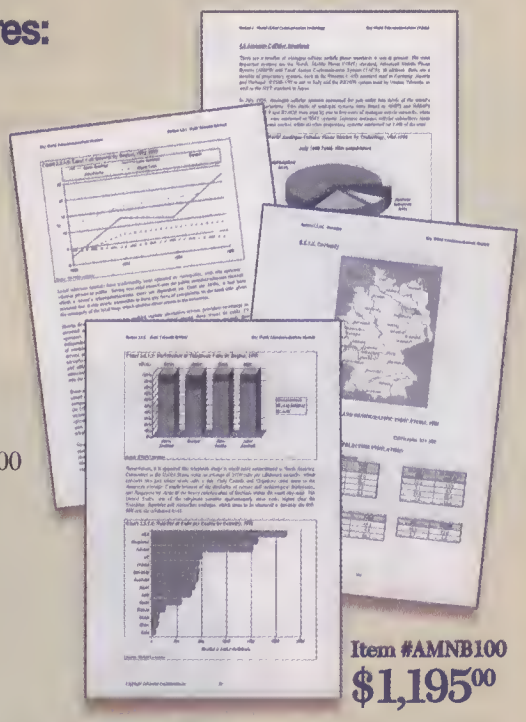

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network needs, causing customers large capital investments. Today, he adds, the most effective infrastructure contender against Lucent is Nortel. "Five years ago, Nortel allowed its software to be modularized to permit multiple applications, both wireless and wireline," he says. "They are the second network provider to have the switch capability to compete with us on a multiapplication basis. A few years ago, upper management at Nortel realized they had to get back into wireless in a big way, so they partnered with Matra for GSM and Motorola for radio technology. Nortel's efforts have been effective, he affirms. "They are the competitor that realizes that wireless must be network-centered, not radio-centered," he says.

"Carriers are much more receptive to the idea of 'farming out' the tower than before; and they are also accepting the realities of co-location."
—Stephen Clark

CALL SCIENCES

Call Sciences introduces architecture for call management applications under its upgraded enhanced services platform, known as Release 6.0. The platform is tailored for modular integration of call processing, database and billing applications and can accommodate a variety of signalling protocols for wireless or wireline networks, including ISDN, SS7 and all European signalling protocols. New technology, called Online Manager, brings message management and call routing profile management via the Internet. OnLine Manager can now access the company's proprietary "Personal Assistant" service, a "single number" service allowing users to update phone/fax and location information without delays. The OnLine Manager lets users change contact number, pager number, e-mail address, available and location schedules, and has been tested effectively in the United Kingdom.

ERICSSON RADIO SYSTEMS

Maintaining its steadfast belief that wideband CDMA is the wave of the third generation, Ericsson Radio Systems' Mats Nilsson, director of technical strategies for future systems, reaffirmed the company's commitment to the Japanese NTT DoCoMo third generation multimedia wireless project. Ericsson is committed to "leapfrogging" narrowband CDMA, showing the industry a wideband (5 MHz or greater) form of the air interface can be used effectively accommodating multimedia data rates of 384 kbps for wide area transmission up to 2 Mbps in indoor applications. Ericsson is counting on the "wireless" Internet and corporate Intranets to fuel demand pull. The company says there will be 600 million wireless users and more than 400 million Internet users by 2001.

LIGHTBRIDGE

In a daring purchase, Lightbridge, a leading provider of customer acquisition and retention solutions, has announced the purchase of Coral Systems Inc., a producer of fraud management and detection software. Lightbridge will focus on integrating Coral Systems' Churn Alert and Fraudbuster with Lightbridge's Churn Profit and Fraud Sentinel Solutions. "There's a synergy between these company's products and cultures," says Michele Wheeler, a Lightbridge product marketing manager. "No one has combined front- and back-end fraud management and screening up until now; we have the front-end capabilities of the Lightbridge Fraud Sentinel with its customer pre-screening and the Coral Systems' back-end to manage the interaction with the switch. This enables us to do predictive modeling [of subscriber fraud]."

Motorola products represented at PCS included the PageWriter 2000 and the MicroTac 650 e*cellular telephone. The PageWriter 2000, a new two-way pager, lets users communicate with other pagers, fax machines and Internet e-mail addresses.

SPECTRASITE COMMUNICATIONS

The new trend in tower management for PCS carriers is to leave the ownership, installation and maintenance to separate companies who will have to deal with all the problems. SpectraSite Communications Inc. (Cary, N.C.) is a new company handling these chores, including site acquisition, construction management and co-location marketing. Chairman Stephen Clark says carriers are much more receptive to the idea of "farming out" the tower than before; and they are also accepting the realities of co-location. "They're turning to companies like us, especially in basic trading areas (BTAs)," Clark says. "We've got the senior people who've already managed 19 BTA launches, and we can present to the carriers a single point of contact that's integrated all these functions into a single service offering. SpectraSite competes with Castle Tower Management in this space.

Which new technologies will affect your work?

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Notebook

DEBBIE L. SKLAR

PAGING INDUSTRY SURGE

Look out cellular users: The paging industry is reporting surprising growth. Paging carriers have added 8.6 million net new subscribers in 1996, topping the record growth of 1995. The **Strategis Group's** latest research report, *The State of the U.S. Paging Industry: 1997*, show s the total customer base has expanded by 25%—reaching 43.1 million units in service at the end of 1996.

"Paging is a cost-effective, reliable means of communication," says Elliott Hamilton, vice president of North American Telecommunications for The Strategis Group. "While we expect advanced messaging to begin to drive growth over the next few years, simple numeric paging remains an enormously popular service."

While many carriers offer a range of enhanced services, adoption among subscribers is still relatively low. Enhanced services offer carriers the opportunity to increase revenue per subscriber and strengthen customer relationships.

The Strategis Group estimates the total of traditional and advanced paging units in service will reach 66.4 million by the end of 2001. Subscribers additions, however, will begin to slow in 1997 as paging carriers emphasize controlled expansion and as the industry matures.

"While we won't see the dramatic subscriber additions experienced in the last two or three years, there is sufficient demand to expand the subscribers base by more than 50% in the next four-and-a-half years," says John Zahurancik, paging analyst for The Strategis Group. "At this stage in the development of industry, slower growth is more of an indication of how widely paging services are used, rather than a hint of doom."

The study also tracks the continued decline of average monthly revenue per unit from $10.51 in 1995 to $9.77 in 1996. However, the increasing popularity of alphanumeric paging,development of advanced messaging service and stabilization of reseller rates are projected to impact average monthly revenue positively.

OHIO TO INSTALL MOTOROLA WIRELESS DATA SOLUTION

Akron was awarded **Motorola's** Land Mobile Products Sector (LMPS) a $3.1 million contract to install a state-of-the-art mobile wireless data solution for the city's police, fire and EMS operations. The system will let public safety officials access information faster while in the field. The system is part of the city's long-range plan to provide communications to public safety entities.

Motorola will upgrade the city's existing two-site, two-channel 4.8 kbps Private Data TAC system to a RD-LAP 19.2 kbps system —one of the first technologies to combine wireless data rates with a reliable data protocol. Motorola also will upgrade the existing message switch and add a redundant message switch. The Message Switches will allow the system to interface with the Ohio LEADS state databases, the Tibuoron computer-aided dispatch (CAD)/RMS and Policeworks Gateway Report Writing programs, and am AVel-Tech Automatic Vehicle Locator (AVL) server. The project will be completed by 1999.

"We are pleased that our new wireless data solution will allow police officers to spend more time fighting crime and less time filling out paperwork," says Akron Mayor Don Plusquellic.

As for the folks at Motorola, Jim Kelly, corporate vice president and general manager, Eastern Division, U.S. and Canada Group, "Motorola's providing the city of Akron with a total wireless data solution taking advantage of a full range of mobile data technologies for police, fire and EMS applications."

Akron's new mobile data system will allow police officers to file reports electronically from the field. Motorola will provide Akron with its PoliceWorks Report Writing mobile applications, allowing police to take advantage of field reporting benefits like inputting and retrieving information directly thorough a host computer, eliminating redundancies. More information at www. motwww.mot.com/LPS.

SPRINT PCS PURCHASES HANDSETS

Sprint PCS has signed a volume purchase agreement for its Code Division Multiple Access (CDMA) handsets with Siemens Wireless Terminals, a unit of Siemens Business Communications Systems Inc. (Richardson, Texas).

Jointly, the companies are designing an easy-to-use handset, including a high resolution color graphic display, long battery life, voice memo capabilities and icon-based menu. The handsets will be dual branded with the Sprint and Siemens names and will be available through Sprint PCS retail centers and third-party retailers in 1998.

"Siemens has made a significant corporate investment to design and manufacture CDMA products in the U.S. for the worldwide market," says Tom Jasney, vice president of sales and service. "As the largest CDMA player in the U.S., Sprint PCS' commitment to Siemens substantiates our investment in CDMA technology and broadens wireless handset product portfolio worldwide."

When the first phase of launch is complete, the Sprint PCS network will encompass 65 cities coast-to-coast, including 40 of the top 50 U.S. metropolitan areas. In phase two, Sprint PCS, will expand its existing coverage, providing services under licenses.Combining Sprint PCS' and its affiliates' licenses—gives Sprint PCS unprecedented licensed coverage of nearly 260 million people. More information is available at www.sprintpcs.com.

ERICSSON, POWERTEL JOIN FORCES

Ericsson and **Powertel Inc.**, a wireless PCS (personal communications service) provider, has been selected as a PCS infrastructure vendor for the Kentucky and Tennessee basic trading areas (BTAs) .

Under the agreement, Ericsson will provide GSM equipment (Global System for Mobile Communication), including mobile switching center, base station controllers and radio base station equipment, as well as implementation and support services. Portel will use the Ericsson equipment for the builder of its BTAs in both states.

MAKING IVR HISTORY

RETROLL
FROM THE AMERICA'S NETWORK ARCHIVES

Dr. Doolittle may have been able to talk to the animals, but whoever would have thought a computer could interactively communicate with a human being in the 1960s? According to an Aug. 1, 1967, *Telephone Engineer & Management* article, there was such an "animal."

Making interactive voice response history, an early computer/phone interface at the Suburban Trust Co. in the Washington, D.C., area was the first audio response system in the country. The system saved time and gave faster service to 250,000 of the bank's customers through its 38 branch offices. It answered internal telephone requests for customer account information in seconds with recorded-voice replies.

The IBM system, named STARS (Suburban Trust Audio Response System), was used by tellers, bookkeepers, department managers and bank officers to query the central computer's files directly from their own stations or offices.

"The system benefits the bank and its depositors in so many different ways that the net result is a significant overall increase in fast, efficient customer service," said J. Robert Sherwood, Suburban Trust president. Suburban Trust officials estimated at the time that STARS relieved bank personnel from a minimum of approximately 400 hours of routine calls per week. An IBM 7770 audio response unit, connected to the bank's central computer, supplied answers to requests within 10 seconds.

Despite any 'technical' differences with today's financial IVR systems, 1967's users of the bank service were probably as underwhelmed with their bank balances as they are today.

SPRINT GETS A LITTLE 'SATISFACTION' FROM ROLLING STONES

Stones menace Sprint CEO William Esrey to get free phones.

Sprint will join Mick, Keith and the rest of the Rolling Stones (in a manner of speaking) when the band kicks off its "Bridges to Babylon" tour in November. Sprint announced its title sponsorship of what is being touted as the hottest concert tour of the year in the U.S. and Canada.

Sprint chairman and CEO William Esrey says, "The addition of the Rolling Stones tour to Sprint's sponsorship portfolio further distinguishes Sprint from other competitors and continues to advance the Sprint brand in a creative and high-profile manner."

Sprint customers will be granted special access to the front of the line for a shot at buying some of the best tickets in the house for Rolling Stones concerts. Fans will be able to call a special toll-free number to take advantage of this unique, special access bonus from Sprint. The number will be publicized in each tour market as the band rolls like a stone, gathering maybe not moss, but at least subscribers, across North America.

Fashion and technology collide

Mini-skirts and leather outfits aren't the only items where you'll find metallic finishes this fall. Last month, Nokia, arguably the world's most innovative mobile phone manufacturer, introduced its newest product, the Nokia 252. Touted (by Nokia) as the "world's most fashionable phone," the Nokia 252 analog cellular phone was presented by supermodel Niki Taylor at the Fashion Cafe in New York.

Like many of the new fall fashions strutting down the catwalk, Nokia 252's 1998 color palette includes a wide range of "high-gloss" and "brushed metallic" finishes (Inspired by lipstick shades?) such as "Midnight Black," "Hunter Green," "Turbo Red," "Pewter," "Antique Bronze" and "Signal Glow," to name a few. After $30 cans of house paint and bedroom sheets, it's just a matter of time before big-name designers start attaching their John Hancocks to cellular phones.

"We are always looking for new ways to blend technology with today's lifestyles," says Matt Wisk, Nokia's marketing director. "What Nokia has inspired marks the transition of the phone—used not only for its function as a personal communication tool, but also as a fashion accessory. Our goal is to give people the choice to express themselves with unique and colorful options to reflect the individual's personal style."

The Nokia 252 in its introductory configuration weighs 6.2 ounces (Almost the same weight as a supermodel) and provides day-long battery endurance with 125 minutes of talk time and 30 hours of standby time.

Single redundancy unit

The Comsat RSI model 3700 Converter Redundancy Unit protects Comsat RSI frequency converters in satellite communications link systems. The 3700 chassis contains two fully redundant power supplies, an embedded microcontroller and front-panel display/control, and can house up to eight converter-specific, rear-mounted automatic protection plug-in modules that switch radio frequency and intermediate frequency channel signals for up to eight up-converters and two standby converters.

The 3700 uses a flexible modular design which, in other applications can be configured for single 1:N and dual 1:N operation. The ability to have two pools of redundancy in a single chassis is beneficial for providing protection switching of both up- and down-converters in the same system.

The rear-mounted plug-in modules are converter-specific and provide IF/RFD signal routing; in each module the IF and RF switches are ganged for simultaneous operation. Each module also contains an RSV-422 control interface for its intended converter, IF-only switch modules can be used when converter protection is required for single-polarity, down-converter systems.

Manual control of the 3700 is performed using front-panel keys and an LCD. *Sematron Europe Group (Basingstoke, Hampshire, UK)*

Call +44-1-344778522 or circle 202

New jitter features

Jitter testing options to the Interceptor 1402S Synchronous Data Hierarchy and Plesiochronous Data Hierarchy (SDH/PDH) Communications Analyzer provide highly-accurate jitter analysis to verify compliance with ITU-T specifications for jitter control.

As networks evolve from PDH to SDH, the complexity of network synchronization has drastically increased. Pointer movements caused by improper synchronization have become the major cause of jitter in demuxed PDH tributaries. In addition, the nature of jitter has changed from periodic to bursty with higher amplitude, and excessive jitter degrades from periodic to bursty with higher amplitude. Excessive jitter degrades the performance of the network by introducing bit errors in the digital signals, which can cause data loss. To help guarantee the quality of services, jitter must be minimized to levels accepted by ITU-T standards.

The Interceptor 402S is a comprehensive PDH/SDH tester with VC12, VC3 and VC4 mapping; full mux/demux among all rates supported to include N x 64 kbps/performance analysis per G.821/G.826 and M.2101; automatic protection switch testing; optical power, insertion loss and return loss measurements; and remote control capability. With the addition of jitter testing capability, the Interceptor 1402S provides a powerful tool for equipment verification, network installation and maintenance. *Telecommunications Techniques Corp. (Germantown, Md.)*

www.ttc.com or circle 201

Modular battery

The MSE-500IIP Modular Battery System is a 2V 500 ahr, eight-hour battery, originally developed in 1985 as a backup power source for communications networks. This high performance valve-regulated lead-acid (VRLA) battery yields superior life and reliability under demanding conditions.

The cell module features a fabricated "unitized" design, exceeding UBC Zone 4 requirements.

Key features include a 13-year lifespan, five-year warranty, thermal stability, minimum 1200 cycles @ 50 % DOD, high-rate discharge performance, and welded and epoxy-sealed terminal posts. Each cell weighs less than 76 pounds. *Panasonic Industrial Co. (Secaucus, N.J.)*

Call 201/348-5266 or circle 208.

Automated Internet billing system

The TotalBill automated billing and customer service system for Internet service providers (ISPs) is designed to automate the billing, payment and account-setup process.

TotalBill can handle hundreds of subscribers without intervention of staff for the billing process. Developed over a two-year period, the system incorporates order/entry, credit card transactions, customer service, technical support, accounts receivable and collections, general ledger, transaction generation, reporting, and change history.

The billing system relies on an Oracle Version 7 database for its data repository, and was designed and developed using Oracle's Designer/2000 and Developer/2000 product line. *Expansion Systems Inc. (Glendale, Calif.)*

www.expansion.com or circle 215

Connectors

Two RingFlare connector models have been designed exclusively for use with Heliax foam dielectric cables, giving ease of installation without sacrificing mechanical or electrical performance.

Fast-fitting RingFlare connectors are designed for the rapid deployment of personal communications services (PCS) and other wireless systems. The models are the L5PDM-RC 7-16 DIN male for LDF4-50A, 7/8 inch Heliax foam-dielectric cable and the L4DM-RC 7-16 DIN male for LDF-50A, ½-in. Heliax foam-dielectric cable.

Andrew Corp. (Orland Park, Ill.)

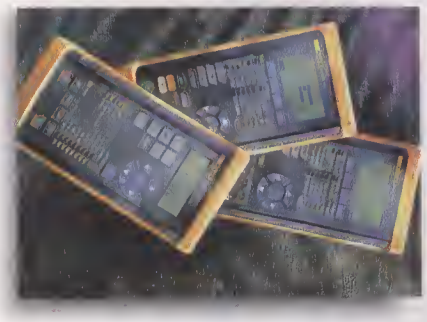
www.andrew.com or circle 217

Handheld analyzers

A family of handheld analyzers for asynchronous transfer mode (ATM) networks let service providers quickly commission new equipment and services.

Available with interfaces for DS1, DS3, E1, E3 or OC3 networks, the handheld analyzers deliver the power of ATM benchtop testing equipment for wide-area network (WAN) applications in a fully portable, rugged design. These ATM network analyzers operate with a set of analysis procedures to address switched virtual circuits (SVCs), Quality of Service (QoS) and other ATM-specified parameters.

The devices apply testing methodologies previously only available in benchtop testing equipment; at the same time, they fill an industry need for lightweight, easy-to-use test equipment that can be easily transported nearly anywhere for conformance, commissioning, installation and maintenance.



The network analyzers offer communication service providers, ATM product developers and private network owners with complete physical layer testing, automatic traffic discovery, QoS testing and ATM service category simulation.

Fluke Corp. (Everett, Wash.)

Call 206/356-5116 or circle 209

Mini OTDR

The MW9070B mini-optical time-domain reflectometer (OTDR) combines fine resolution over long distances with a high dynamic range. This pairing lets users find splices or breaks in fibers with 1 mm resolution over short -and long-haul lines.

Users can take OTDR trace data from any source, combine it with data collected by the MW9070B, and manipulate it on a PC. Hard copy also can be oriented on a desktop printer.

The MW9070B is weatherproof, and meets or exceeds military specifications for shock, vibration, dust and water. It performs relative measurements and has progressive launch attenuation to prevent deep saturation of the detector, which increases accuracy to less than 0.5% and decreases the dead zone to 5 mm. Other modules that can be used with the mini-OTDR include multimode and singlemode units, as well as those in high to modest dynamic ranges.

Price of the 40 dB module is $3,675; base price of the MW9070B is $15,500. Emulation software costs $1,350.

Anritsu Wiltron Co. (Morgan Hill, Calif.)

www.anritsuwiltron.com or circle204

Real-time fraud management system

The Sterling 7000 real-time fraud management system helps carriers solve the $12 billion telecommunications fraud problem in the U.S.

The system uses call detail reports (CDRs) and selected fields from customer databases toidentify suspicious behavior immediately. Once a suspected fraud has been highlighted, carriers can perform continuous monitoring of the situation and can begin a detailed investigation easily. The system provides a consolidated report, which lets carriers observe a single switch, a combined switch group/franchise or the complete domain of interest. It also provides a combined weighting report, which offers an instant, overall evaluation of suspicious behavior on the network. *Ad-hoc* reporting also can be conducted with the Sterling 7000.

Axiom Inc. (Moorsetown, N.J.)

Call 609/866-1000 or circle 212

Decibel dialer

The dB Dialer accepts digital alarm output from up to four sources and can be configured to provide different responses to varying combinations of alarms. For example, when monitoring the performance of a base station, the dB Dialer could be configured to log the occurrence of an AC power failure, but send an alarm call if the DC backup generator also fails.

Other alarm monitoring devices already at the site, such as radio fFrequency power monitors, can be connected to the dB Dialer to give operators the added convenience of remote monitoring.

The dB Dialer uses a standard PC modem to call up to four telephone numbers with the occurrence of an alarm. Calls may be sent to a computer, numeric pager or alphanumeric pager. Predefined text messages call repair personnel with an alarm description, and assign a major or minor alarm status. The PC-based system also enables system engineers to configure the dB Dialer onsite through a serial port or remotely via modem.

Allen Telecom Systems (Cleveland, Ohio)

www.allentel.com or circle 203

Programmable output source

The Model TSI-2109 E1 Programmable Source provides 56 E1 rear panel outputs for complete loading of E1 network equipment. The source also can serve as an E1 clock distribution unit by using the Reference E1 or DS1 input with Pattern 'thru' mode.

Source outputs can be configured in seven blocks of eight outputs each via front panel switches.

An output located on the front panel allows single-error insert for applications such as signal tracing. TSI-2109 E1 Programmable Sources in the central office can be used for remote or loopback tests, reducing the number of bit error rate (BER) test transmitters and the total cost of test equipment required.

The device occupies 1.75 inches of rack space height, making it ideal for central office applications where space is often at a premium. Reports reveal that real panel wirewrap output connectors provide 56 E1 output connectors. A fail contact is available on the rear panel to monitor unit status. *Telesync (Norcross, Ga.)*

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America's Network (ISSN-1075-5292, USPS 576-650) is published the 1st and 15th of every month by Advanstar Communications Inc. Corporate offices: 7500 Old Oak Blvd., Cleveland OH 44130. Advertising offices: 7500 Old Oak Blvd., Cleveland OH 44130 and 312 W. Randolph St., Chicago IL 60606. Accounting & circulation offices: 131 W. First St., Duluth MN 55802.

Canadian G.S.T. number R-124213133. IPM Number 841773.

Office of Publication: Advanstar Communications Inc. 131 W. First St., Duluth MN 55802. Periodicals postage paid at Duluth MN 55806 and additional mailing offices.

POSTMASTER: Send address changes to America's Network, P.O. Box 6100, Duluth MN 55806.
Date: Jan. 28, 1994. Printed in the U.S.A.

ISSN-1075-5292 (USPS 576-650)

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ADVANSTAR EXPOSITIONS

ART BROTHERS

Getting a wireless fix

How FAA tech can help carriers find cell phones.

One of my jobs for the 5th Air Force was as communications supervisor for central Japan's aircraft control and warning network. We had an air defense control center (ADCC) at Johnson Air Force Base near Tokyo. Three tactical control centers were 100-plus miles out. The ADCC had manually plotted information (written backwards) from behind lucite map panels from nine radar sites. Information was gathered by telephone; primary lines were on four-channel military 70 MHz Frequency Modulation multiplex. Dedicated Japanese telephone lines provided backup with High Frequency radio in case of telecom failure.

From the necessity of the military, air traffic control (ATC) has constantly upgraded. ATC's are scattered throughout America. Big Iron airlines drivers can name them all. I've only talked to Seattle, Oakland, Denver and Salt Lake City. These facilities house 20-plus-year-old creaky computers with broadband circuits to haul radar signals to the center from various points within each center's area of control.

FLOW CONTROL

Recent ATC advances include Flow Control. Flow Control came about to avoid having airliners circling around for hours waiting to land when (as an example) too many arrived at the same time.

Flow Control uses new computers which gather and store the position of all aircraft over 14,000 feet high within the U.S. continental airspace. You can "mouse click" any aircraft (a radar dot) on the map, and the computer will tell you all about that target. Or it will find things, like the IL-62 heading across the pole from Moscow to Seattle. Or all Mooney's, irrespective of location.

Flow Control computer data is upgraded by satellite several times an hour. When the Federal Aviation Administration sees too much traffic heading for a major hub, such as New York or Chicago, or there if there is weather—or just too much congestion—planes are not given clearances to take off. It is cheaper and safer to sit on the ground. I've seen more than 30 airliners lined up waiting departure east from Chicago. The Flow Control system is at work. It's a remarkable toy.

Recent Federal Communications Commission actions say that by 2001 cell and SMR operators have to locate a phone within 1,000 feet. Big time expense.

WHERE ARE YOU?

Recent Federal Communications Commission actions say that by 2001 cell and SMR operators have to locate a phone within 1,000 feet. Big time expense. Operators are lucky to reach a customer from one base station, let alone the three required to nail a fix. It would be cheaper for the operator—and even more expensive (and technically not feasible unless outside) for the user—to incorporate a GPS receiver in the handset.

OK, so the locator stuff will not be in the handset. It is not much of a jump, then, to incorporate the central site locator data into a national database like the government already has for its aviation Flow Control system. It will pinpoint any cell phone if within range of two or more cell sites. How many folks pay for that kind of information?

LOCKED COINS

More and more folks are mad at Ameritech and others for locking public phone dial pads so we can't access our answering machines when on the road. Earlier this year I stopped at every public phone I could find in Miami and wasted countless dollars only to find all local exchange carrier and customer owned, coin-operated telephones (COCOT) dial pads locked after I dialed my number. Happened in Chicago, too. Grumble.

COCOT CHARGES

My Beehive Telephone Co. is the certified wireline telephone provider at the U.S. National Park Service's $7 million Lake Powell marina at Dangling Rope, Utah. They only allow me one public phone which provides call card and 800 free access. AT&T rates apply. The park has now allowed a COCOT using cellular to place a pair of their phones at a more visible location on the wall of the marina store—and allowed them use of telephone lines and space in a utility closet in the concessionaire's air conditioned buildings (which they don't allow Beehive to use).

The cost to the public to make a call? $9.75 minimum. No 800 service; VISA, collect or non-891 cards only. Hmm... ■

When Art's head isn't stuck in the wild blue yonder, he's piloting Beehive Telephone Co. (Wendover, Utah) and can be reached at artb@beehive.net.

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